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TEST DATA REPORT, LOW SPEED WIND TUNNEL
TESTS OF A FULL SCALE LIFT/CRUISE - FAN INLET,
WITH ENGINE, AT HIGH ANGLES OF ATTACK

By W. M. Shain

January 1978

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16. Abstract A low speed wind tunnel test of a fixed lip inlet with engine, was performed at NASA-Ames Research Center. The inlet was close coupled to a Hamilton Standard 1.4 meter, variable pitch fan driven by a Lycoming T55-L-11A engine. Tests were conducted with various combinations of inlet angle-of-attack (0-120°), freestream velocities (0-82 m/sec), and fan airflows (70-165 kg/sec-M²). Data were recorded to define the inlet airflow separation boundaries, performance characteristics and fan blade stresses. The report includes descriptions of the test model, installation, instrumentation, test, data reduction and final data. ORIGINAL PAGE IS OF POOR QUALITY					
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CONTENTS

	Page
SUMMARY	1
INTRODUCTION	2
FACILITY	2
INSTALLATION	2
MODEL	3
INSTRUMENTATION	4
DATA REDUCTION	6
TEST PROCEDURE	14
TEST RESULTS	15
TABLES 1-3	16
FIGURES 1-17	19
 APPENDIX A Q-Fan Demonstrator, Lift Fan Technology Program, Blade Stress Report	 36
APPENDIX B Tape Record Logs	90
APPENDIX C Final Data	102
APPENDIX D Test Logs	104

LIST OF FIGURES

	Page
1. Ames 40X80 Foot Wind Tunnel (12.2mx24.4m)	19
2. Wind Tunnel Installation Schematic	20
3. Model Installation	21
4. Nacelle Schematic	22
5. Cowl Static Pressure Instrumentation	23
6. Fan Face Instrumentation	24
7. Fan Face (Front View)	25
8. Fan Duct Instrumentation	26
9. Aft View Fan Nozzle Exit	27
10. Compressor Face Instrumentation	28
11. Core Engine Inlet Instrumentation	29
12. Core Engine Nozzle Instrumentation	30
13. Nacelle Operational Health Monitoring Locations	31
14. Block Diagram, Steady State Data Acquisition System	32
15. Lift/Cruise Fan Inlet Test Instrumentation System	33
16. Data Sheet Format	34
17. Nacelle Force Measurements - Nomenclature and Sign Convention.	35

LIST OF TABLES

	Page
1. Magnetic Tape/Data Recording Channel Assignments	16
2. Lift/Cruise-Fan Inlet Test, Data Reduction Tables	17
3. Summary of Test Conditions	18

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1. Syberg, J; Koncsek, J. L.; "Low Speed Tests of a Fixed Geometry Inlet for a Tilt Nacelle V/STOL Airplane" Boeing Document D180-20276-1 dated January 1977, (NASA CR-151922 dated January 1977).
2. Syberg, J.; "Test Planning and Coordination Lift/Cruise Fan Inlet Test Program" Boeing Document D180-20725-1 dated July 1977.
3. Syberg, J; "Low Speed Tests of a High Bypass Ratio Propulsion System with an Asymmetric Inlet Designed for a Tilt Nacelle VSTOL Airplane" Boeing Document D180-22888-1, November 1977, (NASA CR-152072 dated January 1978).

SUMMARY

A low speed wind tunnel test of a fixed lip inlet operating at high angles-of-attack was performed in the NASA-Ames Research Center (NASA-ARC) 12.2 X 24.4 meter wind tunnel (40 X 80 WT). The purpose of the test was to demonstrate total pressure recovery and distortion levels which result in acceptable fan/core engine stall margins and blade stress levels. These characteristics would be demonstrated when operating at combinations of high angles-of-attack, freestream velocities and engine airflows. The inlet was designed and built by Boeing, was asymmetric, with a contraction ratio varying from 1.30 (leeward) to 1.76 (windward). It was matched to a Hamilton Standard 1.4 meter (55") fan driven by a Lycoming T55-L-11A gas turbine engine. The test model (nacelle) was mounted on its side on a turntable, approximately 3.8 meters (12.6') above the wind tunnel floor.

The nacelle contained approximately 225 parameters measured/recorded by a Boeing supplied data system. Measurements were also made of the nacelle lift, drag, and side forces and the pitch, yaw and rolling moments. Key operational and monitoring parameters were also recorded in real time on magnetic tape recording systems. The model performance data were reduced on site into a semi-final form for test progress analysis and the tape recorded data were available for, if needed, historical analysis.

Tests were first run to define the inlet airflow separation boundaries as a function of angle-of-attack. An airflow and tunnel velocity was set and the model slowly pitched until separation occurred within the inlet. Data were recorded at discrete points approaching the separated conditions as defined by monitoring the dynamic pressure activity at the windward side of the fan face. Data were also recorded later defining the angle-of-attack and airflow hysteresis (attached/ separated/re-attached) characteristics. Following definition of the operating placard, tests were run at fixed angles of attack and velocity with varying airflow to define in detail the inlet performance characteristics.

The model occupied the wind tunnel for five weeks, three of which were required to repair the wind tunnel after a drive motor failure. Tests were done on a single shift basis and covered angle-of-attack ranges from 0 to 120 degrees, freestream velocities of 0 - 82 meters/sec (160 kts) and fan airflows of 70 - 165 kg/sec-M² (14 - 34 lb/sec-ft²). Approximately 240 data conditions were recorded during 20 hours of engine operation. Included in the report are detailed descriptions of the model, installation, instrumentation and test procedures. Also included are the test, engine and instrumentation logs along with the final model performance and blade stress data.

INTRODUCTION

During the first part of 1976, The Boeing Aerospace Company, Military Airplane Development was awarded, by NASA-Ames Research Center, an inlet design contract in support of a multi-mission VSTOL airplane, contract NAS2-9215. The performance of a Boeing fixed lip inlet would be demonstrated on a Hamilton-Standard Q-Fan (M) demonstrator/T-55 engine operating in a severe "angle-of-attack" environment provided by the 40 X 80 WT. Boeing was the prime contractor responsible for the inlet and nacelle design, fabrication and assembly, installation, wind tunnel test and data analysis. The responsibility for supplying the core engine/fan system along with its operation during test was sub-contracted to Hamilton-Standard (HS).

The main objective would be to demonstrate that a fixed lip inlet can provide adequate pressure recovery and distortion levels that result in acceptable core engine/fan stall margins and fan blade stress levels at combinations of large nacelle tilt angles, freestream velocities and engine airflow levels.

Initial testing in the wind tunnel began in July 1976. After several days of testing, a gear failure in the fan gearbox temporarily ended testing. The test was resumed, after gearbox repairs, in September of 1976. Again after several days of testing the same gear failed and severely damaged the core engine. The test was again stopped without acquiring enough data to meet the original objectives. Details of these tests were reported in Reference 1.

In June 1977, a new contract, NAS2-9640, was issued as a follow-on to complete the initially planned test series. The HS gearbox was analyzed, redesigned, remanufactured and verification tested to assure structural integrity. Testing was resumed in the fall of 1977.

FACILITY

Testing was performed in the NASA-ARC Wind Tunnel. The Wind Tunnel has a closed 12.2 by 24.4 meter (40' X 80') test section with semi-circular sides of 6.1 meters (20') radii, and a closed circuit air return passage. The general arrangement is shown in Figure 1. Air is driven in the wind tunnel by six 12.2 meter (40') diameter fans which are powered by six, 6,000 horsepower electric motors. The tunnel operates with a stagnation pressure equal to atmospheric. The stagnation temperature varies from ambient upwards, due to the entrained products of combustion and the heat from the tunnel drive system.

INSTALLATION

A schematic of the test model, installed in the wind tunnel, is shown in Figure 2. The main wind tunnel model support struts were removed and

the semi-span turntable installed for mounting the nacelle. The nacelle was bolted atop a Boeing designed pylon-strut which in turn was bolted to the turntable. This entire assembly was mounted "on balance" for measuring the model forces. A large fairing was designed and built to fit around the strut and turntable and mounted "off balance" to provide shielding from the Wind Tunnel air forces. The centerline of the nacelle was 3.84 meters (12.6') above the Wind Tunnel floor and located on the vertical centerplane of symmetry in the Wind Tunnel.

The center of the installation, or center of rotation, was at tunnel station 261.5. A model alignment check was done after installation and the model was determined to be 0.2° nose down at 0° angle of attack. No correction was made for this slight deviation from the horizontal.

The rotation of the semi-span turntable is in the horizontal plane (normal inlet yaw) and since the inlet was asymmetric the inlet was installed on its side, i.e., the 90° position on the inlet lip was up in the wind tunnel. This exposed the windward designed side of the inlet to the tunnel flow at angles of attack. Figure 3 shows the model installed in the wind tunnel.

The peripheral support equipment, other than the instrumentation systems, were mainly hydraulic and lubrication supply systems for the variable pitch fan. One high pressure pump, reservoir and cooler were located on the first floor, with a gear box lubrication supply and scavenging pump (2) located on the second floor. The high pressure pump supplied fluid for the fan blade pitch change and control system and the engine power lever position. The lube and scavenge pumps supplied and scavenged the fan gear box of lubrication oil. Fuel for the engine (JP-5) was supplied from the facility system.

The onboard fire system consisted of manifolded nozzles within the core engine cowl attached to two high pressure nitrogen bottles. In the event of an external engine fire the cavity inside the cowl would be filled with inert gas (N_2). More detailed information regarding the installation support equipment may be found in the Plan of Test, Reference 2.

MODEL

The test model, or nacelle, consisted of an inlet, a variable pitch fan, a gas turbine core engine, and the appropriate fairings, nozzles etc.

The inlet has a 1.469 meter (57.826") highlight diameter, a 1.2 meter (47.236") throat diameter and a 1.397 meter (55") fan face diameter. The inlet contours are asymmetric with the windward side (180°) having a higher contraction ratio than the leeward side (0°). The contraction

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ratio varies from 1.76 at 180° to 1.30 at 0°. At a given inlet station, both the internal and external contours are circular in cross section with offset centers. The inlet cowl was made of fiberglass.

The Hamilton-Standard Q-Fan TM demonstrator is a 1.397 meter (55"), 13 bladed, variable pitch fan which utilizes a Lycoming T55-L-11A, 3750 hp gas turbine as the core engine. The fan has 17:1 bypass ratio and is driven through a 4.75:1 gear reduction to a maximum speed of 3365 rpm. The fan system used a .645 meter (25.4") diameter "semi-elliptical" nose dome fairing. The fan exit nozzle was a simple, round, constant area, aluminum nozzle with an exit area of 1.064 sq. meters (1649 square inches). The core engine exit nozzle supplied with the engine, had an exit area of .254 sq. meters (394 square inches). A schematic of the inlet and nacelle showing the major components and station designations is shown in Figure 4.

INSTRUMENTATION

The test model instrumentation was divided into three groups: 1) Model performance, 2) Fan/engine operation and health and 3) Wind Tunnel condition. A brief description of each group follows:

Model Performance

INLET: The inlet contained 45 cowl surface static pressure ports, Figure 5, and seven fan face total pressure rakes (70 total pressures, 7 statics and 3 flush mounted total pressure transducers,) Figure 6. These rakes are also shown in the photograph, Figure 7. One flush mounted Kulite was located near the inlet throat at 180° in the cowl wall.

FAN DUCT: The fan duct had two rakes located just ahead of the fan nozzle exit, Figure 8. The rakes each contained 10 total pressures, 3 total temperature probes, one Prandtl-type static probe (two flush surface statics were also on the core engine cowling) and are shown in Figure 9.

CORE ENGINE: The core engine compressor face was instrumented with eight, 6 probe total pressure rakes (44 total pressures and 4 flush mounted transducers), and 8 static pressure ports, Figure 10. Three total pressures and one static were located at 0° on the core compressor inlet lip, Figure 11.

Engine performance was determined by measuring N1, N2, and power shaft torque. The engine nozzle contained four static pressures, Figure 12.

Fan Engine Operation and Health Monitoring

INLET: Inlet performance was monitored on-line through use of one X-Y and two X-YY plotters. The X-Y plotter was used to monitor the fan face radial total pressure profile at 180° (rake No. 4). The two X-YY

plotters were used for monitoring RMS peak-to-peak pressure dynamics versus model angle-of-attack or airflow; one plotter for two of the fan face/inlet Kulites and the other for two of the compressor face Kulites. All eight of the Kulites (PDF1-3; PDC1-4; PDS) were also visually monitored on RMS meters. Three of the seven fan face total pressure rakes were strain gaged near the root to monitor stress levels during testing.

FAN: Fan operation and health was monitored basically by RPM, blade angle, blade stress (5 blades were strain gaged) and vibration. In addition, the gearbox lube oil pressure, temperature and flow rate were displayed along with other key temperatures and vibrations. Several (6) proximeter probes, located in the fan gear box, were used to monitor spacial displacement of the sun and ring gears.

CORE ENGINE: The engine system contained all the normal monitor and control parameters, N1, N2, TT7, oil pressures, level and temperatures (various locations), vibration pickups, power lever angle and fuel supply pressures. In addition engine external structure and cowl cavity temperatures were displayed on panel meters.

The various temperature sensors, vibration pickups and proximeter probe locations used in monitoring the nacelle system operation are shown schematically in Figure 13.

Wind Tunnel

The Wind Tunnel instrumentation consisted of measuring the total pressure, dynamic pressure, and the total temperature. In addition the model lift, drag and side forces, pitch, yaw and rolling moments were measured by the facility balance system.

Data Systems

The various test parameters were recorded on several data systems. Model performance data on a Boeing steady state data acquisition system, wind tunnel and force information on the facility data system, fan operation and health on a HS tape recording system and select, representative parameters for system diagnostic studies, should they be needed, on a Boeing tape recording system. Engine operational parameters were also hand recorded on the engine logs.

The steady-state data acquisition system, Figure 14, consisted of the various sensors, signal conditioners and a Hewlett-Packard (HP) 3052A automatic digital data system. The HP 3052A contained a 40 channel scanner, digital voltmeter, programmable calculator/controller, line printer and a paper tape punch. Data were recorded on magnetic tape (cassettes), punched paper tape and a line printout.

The various wind tunnel condition parameters and force balance data were recorded on the facility data system. These values were continuously displayed on-line and output on punched paper tape for each test condition.

The two tape recording systems were utilized for recording real-time data defining and/or monitoring critical operational/conditional parameters. Table 1 lists the various parameters recorded and their recording location. The HS system was used to record the fan blade strain gages (stress) and enough peripheral information to define operating conditions. This data was then used in developing the "Blade Stress Report" contained in Appendix A. These tapes were retained and stored by HS. A tape log of the contents of these tapes is also contained in the "Blade Stress Report". The main purpose of the Boeing tape recording system was to provide a real time record of the transient flow conditions within the fan and core engine. This data could then be used in analyzing any failure or anomalies which might occur during testing. The data, as of yet, has not been required for any analysis. The tapes remain stored at NASA-ARC. Tape logs of their identification, content and calibrations are contained in Appendix B.

A complete schematic of the data acquisition and monitoring system is shown in Figure 15.

DATA REDUCTION

The punched paper tapes from the Boeing steady-state data acquisition system and the wind tunnel data system were input to the NASA IBM 360 computer system. The data were calibrated, combined and then calculated for on-site, "short-turn-around" data. The original data tapes were then returned to Seattle for final editing, reprocessing, conversion to Standard International (S.I.) units and plotting. This data has been reproduced and is contained on microfiche as Appendix C.

The data were processed in Seattle with program PN026. The following pages list the basic equations and constants. Item numbers refer to the printout location shown in the "Data Sheet Format", Figure 16.

1. Test Number - Boeing Test Identification 2593. NASA-ARC Test 513
2. W/T inputs - V0 - Wind Tunnel Velocity - KTS; Alpha - Nacelle angle-of-attack-Degrees; Q-Dynamic pressure, PSF; PTO-Tunnel Total pressure psia; TTO - Tunnel Total Temperature - °R; Tunnel Static pressure, psia $P_0 = P_{TO} - Q_{PSF}/144$
3. Barometric Pressure - Reference pressure, psia: All recorded pressures were referenced to barometric
 $P_{ACTUAL} = P_{BAR} \pm S/V \text{ reading.}$
4. Inlet corrected Airflow, lbs/sec

$$WK1 = WK1A * 12.98$$

4a. $WK1A = 46.315 \cdot CDT / PTFA, \text{ lb/sec-ft}^2$

CDT was obtained from model scale data where the inlet airflow was calibrated as a function of the average inlet throat static pressure PAV

$$PAV = (PC13 + PC33 + PC37 + PC38) / 4PTO$$

PAV vs CDT - Table 2

PTFA = item 6

5. Inlet Airflow, lb/sec

$$W1 = WK1 \cdot \delta_T / \sqrt{\theta_T}$$

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where

$$\theta_T = T T O / 518.688$$

$$\delta_T = P T O / 14.696$$

6. Fan face average total pressure recovery, area weighted.

$$PTFA = PTFAV / PTO$$

$$6a. \quad PTFAV = 1/1869.12 \sum_{n=1}^{10} PTFR_n (A_n) \quad \text{psia}$$

$$PTFR = 1/7 \sum_{n=1}^7 PTFX_n$$

6b. $PTFX_n$ = Individual fan face total pressures, number x,

A_n = Area Weighting factor

n	A-in ²	PTF-X
1	93.462	1, 11, 21, 31, 41, 51, 61
2	93.462	2, 12, 22, 32, 42, 52, 62
3	280.362	3, 13, 23, 33, 43, 53, 63
4	280.362	4, 14, 24, 34, 44, 54, 64
5	280.362	5, 15, 25, 35, 45, 55, 65
6	280.362	6, 16, 26, 36, 46, 56, 66
7	280.362	7, 17, 27, 37, 47, 57, 67
8	93.462	8, 18, 28, 38, 48, 58, 68
9	93.462	9, 19, 29, 39, 49, 59, 69
10	93.462	10, 20, 30, 40, 50, 60, 70

7. Fan face total pressure distortion

$$DISF = (PTFXMAX - PTFXMIN) / PTFAV$$

8. Fan duct airflow, lbs/sec

$$WF = \sum_{n=1}^{20} \frac{A_i P_{TM_n}}{\sqrt{518.688} \sqrt{\theta_F}} \left\{ \frac{2g \gamma}{R(\gamma-1)} \left[\left(\frac{PM}{P_{TM_n}} \right)^{\frac{2}{\gamma}} - \left(\frac{PM_n}{P_{TM_n}} \right)^{\frac{\gamma+1}{\gamma}} \right] \right\}^{1/2}$$

$$\gamma = 1.4015$$

$$g = 32.1741 \text{ ft/sec}^2$$

$$R = 53.35 \text{ ft-lb/lb}^\circ\text{R}$$

8a. PTM = Fan duct nozzle total pressure

8b. PM = Fan duct nozzle static pressure:

$$\text{for } 1 \leq n \leq 10 = (PM2-PM) \left(\frac{R_n - 18.61}{10.65} \right) + PM2, R_n = \begin{matrix} 28.73 \\ \uparrow \\ 18.91 \end{matrix}$$

$$\text{for } 11 \leq n \leq 20 = (PM4-PM3) \left(\frac{R_n - 18.61}{10.65} \right) + PM4$$

$$A_i = f(P_{TM_n})$$

n	A _i - in ²	Radius
1,11	117.1	28.73
2,12	110.5	27.4
3,13	99.8	26.16
4,14	90.7	24.98
5,15	82.5	23.86
6,16	75.	22.79
7,17	68.4	21.77
8,18	63.5	20.78
9,19	58.5	19.83
10,20	60.2	18.91

$$8c. F = \left(\frac{1}{6} \sum_{n=1}^6 T_{TM_n} \right) / 518.688$$

T_{TM} = fan duct nozzle total temperature

9. Fan duct corrected airflow, lbs/sec

$$WKF = WF * \sqrt{\theta_F} / \delta_F$$

$$\text{where } \delta_F = PTMAV/14.696$$

$$9a. \quad PTMAV = .992 \left[\frac{1}{1649} \sum_{n=1}^{10} \left(\frac{PTM_n + PTM_{n+10}}{2} \right) A_n \right] \quad \text{psia}$$

A_n = two times the values shown in A_i (8b) table, for values $1 \leq N \leq 10$

10. Core engine compressor face airflow, lb/sec

$$WE = \sum_{n=1}^8 WER_n$$

$$WER = \frac{16.96 * PTCAR_n}{\sqrt{TTC}} \left\{ \frac{2g}{R(\gamma-1)} \left[\left(\frac{PSC_n}{PTCAR_n} \right)^{\frac{2}{\gamma}} - \left(\frac{PSC_n}{PTCAR_n} \right)^{\frac{\gamma+1}{\gamma}} \right] \right\}^{1/2}$$

PTCAR = The individual core engine rake average pressure.

- 10a. TTC = Core engine compressor face total temperature, °R

- 10b. PSC_n = Core engine compressor face static pressure aligned with each core engine rake arm.

11. Core engine compressor face corrected airflow.

$$WKE = WE * \sqrt{\theta_E} / \delta_E$$

$$\theta_E = TTC/518.688$$

$$\delta_E = PTCAV/14.696$$

11. Continued

PTCAV = Area weighted average total pressure at the compressor face, psia

$$= \sum_{n=1}^{48} \frac{PTC_n}{48}$$

11a. PTC = Individual total pressures (48) at the core engine compressor face

12. Area weighted average total pressure recovery, core engine compressor face.

$$PTCA = PTCAV/PTO$$

13. Core engine compressor face total pressure distortion

$$DISC = (PTCMAX - PTCMIN)/PTCAV$$

14. Core engine horsepower

$$EP = 2 \pi * ET * N2/33000$$

14a. where ET = Core engine torque (Table 2)

N2 = Power turbine speed

15. Corrected core engine nozzle thrust - table look-up (Table 2), 1b_f FKN vs. corrected engine horsepower (CP)

$$CP = EP / (\sqrt{\theta_E} * \delta_E)$$

16. Core engine nozzle thrust, 1b_f

$$FN = FKN * \delta_E$$

17. Core engine nozzle exit velocity, ft/sec

$$VN = FN * (g/WE) + FF$$

where FF is a table look-up (Table 2)

FF vs. KN1

KN1 = Corrected compressor speed, N1.

18. Calculated inlet airflow, 1b/sec

$$W2 = \sum_{n=1}^{70} \frac{A*PTF_n}{\sqrt{TT0}} \left\{ \frac{2g \gamma}{R(\gamma-1)} \left[\left(\frac{PPA_n}{PTF_n} \right)^{\frac{2}{\gamma}} - \left(\frac{PPA_n}{PTF_n} \right)^{\frac{\gamma+1}{\gamma}} \right] \right\}^{1/2}$$

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18. Continued

$A = A_n/7$ (from the A_n table used in the calculation of PTFAV)

PPA = Interpolated average static pressure for each fan face total pressure probe.

$$= \frac{(PCz - PPy) * (RA - 13.797)}{13.703} + PPy \quad \begin{array}{l} RA \\ \uparrow \\ 27.228 \\ 13.237 \end{array}$$

18a. PC = Inlet cowl compressor face static pressure

18b. PP = Fan face rake prandtl static pressure

N	z	y
$1 \leq n \leq 10$	39	1
$11 \leq n \leq 20$	40	2
$21 \leq n \leq 30$	41	3
$31 \leq n \leq 40$	42	4
$41 \leq n \leq 50$	43	5
$51 \leq n \leq 60$	44	6
$61 \leq n \leq 70$	45	7

19. Calculated inlet corrected airflow, lb/sec

$$WK2 = W2 * \sqrt{\theta_T} / \delta_T$$

20. Total fan face airflow (calculated), lb/sec

$$W3 = WF + WE$$

21. Fan pressure ratio

$$FPR = PTMAV/PTFAV$$

22. Fan duct exit velocity, ft/sec

$$VM = 2gR \left(\frac{\gamma}{\gamma-1} \right) * TTMAV \left[1 - \left(\frac{PMAV}{PTMAV} \right)^{\frac{\gamma-1}{\gamma}} \right]^{1/2}$$

TTMAV = Average fan duct nozzle total temperature

$$TTMAV = \frac{1}{6} \sum_{n=1}^6 TTm_n$$

PMAV = Average fan duct nozzle static pressure.

$$1/4 \sum_{n=1}^4 PM_n$$

23. Corrected compressor speed, rpm

$$KN1 = N1 / \sqrt{\theta_E}$$

24. Corrected power turbine speed, rpm

$$KN2 = N2 / \sqrt{\theta_E}$$

25. Fan inlet cowl surface Mach number

$$MC_n = \left\{ \frac{2}{\gamma - 1} \left[\left(\frac{PTO}{PC_n} \right)^{\frac{\gamma}{\gamma - 1}} - 1 \right] \right\}^{1/2} \quad n = PC1 \text{ thru } 45$$

26. Force Balance (reference Figure 17)

$$\begin{aligned} FX &= \text{Nacelle drag force, lb}_f & QX &= \text{Nacelle roll moment, ft. lb}_f \\ FY &= \text{Nacelle lift force, lb}_f & QY &= \text{Nacelle yaw moment, ft. lb}_f \\ FZ &= \text{Nacelle side force, lb}_f & QZ &= \text{Nacelle pitching moment, ft. lb}_f \\ FXY &= \text{Resultant nacelle axial force} = (FX^2 + FY^2)^{1/2}, \text{ lb}_f \end{aligned}$$

27. Fan blade angle β - degrees 43°-170°

28. Core engine power lever angle - degrees 0-100°

29. Fan and compressor face. Kulite pressures - RMS PSI/PTO

30. Steady state data acquisition system measured tunnel total and static pressure and total temperature (for use as a backup)

Note: Individual pressure measurements tabulated on data sheets (items 6b, 8a, 8b, 10b, 11a, 18a, 18b, 25a,) are ratioed to PTO.

31. Core engine exhaust gas temperature °R.

In addition to the Max minus Min-over-average distortion for the core engine, an "Allison Distortion Index" was calculated from the compressor face total pressure data. This data were output on a separate page. The index is calculated using the following procedure. First the rake average total pressure for each of the eight rake arms are calculated. Next the rake average pressures for 12 imaginary arms are calculated. These pressure have the following relationship to the actual recorded pressures.

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Imaginary = $\frac{5}{6}$ of the average of Actual Rake No. (A) + $\frac{1}{6}$ of the average of Actual Rake No. (C)

Rake No. (A)	Rake No. (B)	Rake No. (C)
1 (30 deg)	8	1
3 (90 deg)	7	6
4 (120 deg)	6	7
6 (180 deg)	5	4
7 (210 deg)	4	5
9 (270 deg)	3	2
10 (300 deg)	2	3
12 (360 deg)	1	8

Imaginary = $\frac{1}{2} \left[\text{Average of Actual Rake No. (B')} + \text{Average of Actual Rake No. (C')} \right]$

Rake No. (A')	Rake No. (B')	Rake No. (C')
2 (60 deg)	7	8
5 (150 deg)	5	6
8 (240 deg)	3	4
11 (330 deg)	1	2

From these rake average pressures, the twelve contiguous 120 degree sector average pressures are calculated. The minimum 120 degree sector is then located from this array.

The average compressor face total pressure (PTCAV) is calculated as the arithmetic average of the original 48 recorded pressures. Since ring number 3 lies close to the radius that separates the outer 40 and inner 60 percent of the total compressor face area the outer 40 percent average total pressure (PTCRPA) is calculated as the arithmetic average of rings 1-3 and inner 60 percent total pressure (PTCRFA) as the arithmetic average of rings 3-6. Radial total pressure distortion is then calculated as

$$KR = PTCRPA - PTCRFA/PTCAV$$

The circumferential total pressure distortion is calculated as

$$KTHETA = PTC_{AV240} - PTC_{AV120}/PTCAV_{360}$$

The composite distortion index is calculated as

$$KCOMP = (KR^2 + KTHETA^2)^{1/2}$$

All of the data were calculated using the formula and definitions in the preceeding pages. All constants, etc. were in English units. The final conversion to SI units was done by a multiplication factor applied to the computed or calibrated English value. These conversion factors are listed in Table 2.

TEST PROCEDURE

Testing was done on second shift, with first shift being utilized for troubleshooting and model maintenance. For safety considerations, due to the previous experiences with the test model, engine running was not permitted before 5:00 p.m. At the beginning of each day's testing and/or run startup the data systems were all check calibrated and adjusted for the proper barometric readings. A wind-off zero was taken on the force measuring system. The following general sequence was then followed:

1. Start Wind Tunnel into the synchronizing mode.
2. Start fan gearbox scavenging pump.
3. Start fan gearbox lubrication pump.
4. Start fan blade and PLA control hydraulic pressure pump.
5. A final inspection of the facility and model test systems was completed.
6. The tape recorders were turned on.
7. The engine was started.
8. The Wind Tunnel access door was closed.
9. The Wind Tunnel was then brought on-line.
10. The engine was left at idle power until the Wind Tunnel speed was within approximately 60% of the end value. The engine/fan system was set at an intermediate-to-high power setting (usually around $N_2 = 12000$ rpm) and the nacelle was yawed to the desired angle-of-attack. The engine and wind tunnel were then trimmed to the required setting.
11. After 20-40 seconds stabilization time data were recorded on both the wind tunnel and steady-state data systems. (The tape recorders were left on-continuously during testing and each run/condition number was announced on the tape.)
12. The model was then reset to a new angle of-attack and/or the air/flow was changed for the next condition number.

Detailed logs were kept during testing defining the wind tunnel, fan-engine, and data conditions. These logs are included as Appendix D and include "Test Logs", "Engine Logs", and "Tape Record Logs". Detailed information noting the pertinent parameters and any erroneous or peculiar data or conditions are recorded.

TEST RESULTS

The test nacelle was assembled and instrumented in Seattle in July, August, 1977. A functional check of the data systems was also performed at this time. The model was shipped from Seattle, completely ready to install in the wind tunnel. Wind tunnel occupancy began on September 12, 1977, with testing beginning on September 16. After a "static conditions" airflow sweep (full power to idle power) testing were done to define the low airflow inlet separation boundaries with varying angle-of-attack. The airflow (fan rpm, Blade angle) was set a constant value and the nacelle was rotated (increasing α) until airflow separation occurred within the inlet. This was determined by on-line monitoring of the windward side fan face total pressure profile and the dynamic pressure fluctuations. This was done at nominal tunnel velocities of 20, 38, 46, 54, 64, 72 and 82 meters/sec (40, 75, 90, 105, 125, 140 and 160 kts). These tests were then followed by more definitive testing at a fixed angle-of-attack and velocity with varying airflow rates.

On September 23, 1977, testing was interrupted by a failure in one of the tunnel main drive motor/generator sets. The repair took approximately three weeks and testing resumed on October 13, 1977. The test was finished on October 15, 1977. During the latter portion of testing data were recorded with the airflow separated to the inlet lip providing none of the prescribed system limits or stresses were exceeded during the time-on-condition. Prior to this, time data had been recorded only up-to-near lip separation. The hysteresis characteristics of these separated airflow conditions were evaluated both by increasing/decreasing angle-of-attack and decreasing/increasing rpm (separated/attached). A detailed analysis of the data, inlet performance characteristics and specific test results may be found in Reference 3. Table 3 summarizes the conditions, velocity and angles-of-attack tested and the applicable test run numbers.

TABLE 1
MAGNETIC TAPE/DATA RECORDING CHANNEL ASSIGNMENTS

<u>PARAMETER</u>	<u>TAPE TRACK</u>
<u>Boeing Tape Recording System</u>	
Fan Face Dynamic Pressure PDF1	1
Fan Face Dynamic Pressure PDF2	2
Fan Face Dynamic Pressure PDF3	3
Cowl Static Dynamic Pressure PDS	4
Compressor Face Dynamic Pressure PDC1	5
Compressor face dynamics pressure PDC2	6 (Reels 1-6)
Model Angle of Attack α	6 (Reels 7-11)
Compressor face dynamic pressure PDC3	7
Compressor face dynamic pressure PDC4	8
Fan Blade Strain Gage	9
Fan Blade Strain Gage	10
Power Turbine Speed N_2	11
Fan Blade Angle β	12
Fan Face Pressure Rake Stress	13
IRIG "B" Time Code	14
<u>VOICE</u>	<u>EDGE TRACK</u>
<u>Hamilton Standard Tape Recording System</u>	
Fan Blade Stress #1 Bending	1
Fan Blade Stress #6 Bending	2
Fan Blade Stress #7 Bending	3
Fan Blade Stress #2 Vee	4
Fan Blade Stress #9 Vee	5
Fan gear vibration fore & aft	6
Fan gear vibration lat.	7
N_2 /Sta. MPX #1	8
Sta. MPX #2	9
Torque	10
Fan Blade Angle	11
Fan Speed - 1P	12
Voice	
Proximity Probe #1 - Ring gear	1
" #4 - Ring gear	2
" #7 - Retaining Nut	3
" #6 - Sun gear	4
" #10 - Retaining Nut	5
Gearbox vibration vertical	7
Gearbox vibration vertical	9
Inlet vibration vertical	10
Inlet vibration horizontal	11
Proximity probe #9 Sun gear	12
} Multiplexed	

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TABLE 2

LIFT/CRUISE - FAN INLET TEST, DATA REDUCTION TABLES

Inlet Corr. Airflow Vs. Calibration Pressure		Engine Torque Vs. Torquemeter Indication		Corrected Fuel Flow vs. Corr. Engine Speed		Corrected Thrust Vs. Corr. Power		S.I. Conversion Constants		
								From	To	Multiply By
PAV	CDT	Indication % of 1300 lb-ft	ET inch-lb	$N^1/\sqrt{\theta}$ %18720 RPM	WF/δθ lb/hr	EPK hp	FKN lb	KTS FPS	M/SEC M/SEC	.5144 .3048
		10	1550	55%	340	0	0	1b/ft ²	BAR	.0004788
.55	.961	15	2350	60	390	200	30	1b/in ²	BAR	.068948
.60	.937	20	3150	65	450	400	53	1b/sec	Kg/sec	.45359
.65	.904	25	3900	70	520	600	73	°R	°K	.55556
.70	.860	30	4600	75	620	800	91	ft-lb _f	Newton-	
.75	.806	35	5300	80	750	1000	108		Meters	1.356
.80	.739	40	5900	85	940	1200	123	1b _f	Newton	4.448
.85	.654	45	6550	90	1220	1400	138	HP	KW	.7457
.90	.546	50	7150	95	1620	1600	152	1b/sec-ft ²	Kg/Sec-M ²	4.8826
.925	.478	55	7750	100	2120	1800	165			
.950	.390	60	8350			2000	178			
.975	.250	65	9000			2200	191			
1.0	0	70	9650			2400	203			
		75	10350			2600	215			
		80	11150			2800	226			
		85	12000			3000	238			
		90	13000							
		95	14150							
		100	15450							

TABLE 3 SUMMARY OF TEST CONDITIONS

Run Number	Velocity		Angle-of-Attack	No. of Airflows
	M/Sec	(KTS)	Degrees	
3	0	(0)	0	6*
4	20.6	(40)	90 - 120	Const. (1)**
29	"		90	3
30	"		120	9
23	30.9	(60)	75	5
24	"		90	7
25	"		105	7
5	38.6	(75)	70 - 94	Const. (3)
9	"		0	5
38	"		20	3
10	"		60	5
11	"		75	6
13	"		90	12
31	46.3	(90)	70 - 81	Const. (1)
26	"		60	8
27	"		75	9
28	"		90	5
6	54.1	(105)	50 - 95	Const. (4)
12	"		0	5
37	"		20	3
14	"		60	7
15-16	"		75	6
32	64.4	(125)	48 - 84	Const. (5)
17	"		60	8
7	72.1	(140)	40 - 68	Const. (5)
18-19	"		0	9
35	"		20	3
20	"		45	17
36	"		60	5
33	"		70 - 71	Const. (1)
34	82.4	(160)	39 - 63	Const. (4)

* Airflow was usually varied between nominal values of 73.2 kg/sec M² (15 lb/sec ft²) and 166 kg/sec M² - (34 lb/sec ft²).

** Constant airflow conditions with varying angle of attack
() = Number of airflows at which an alpha sweep was done

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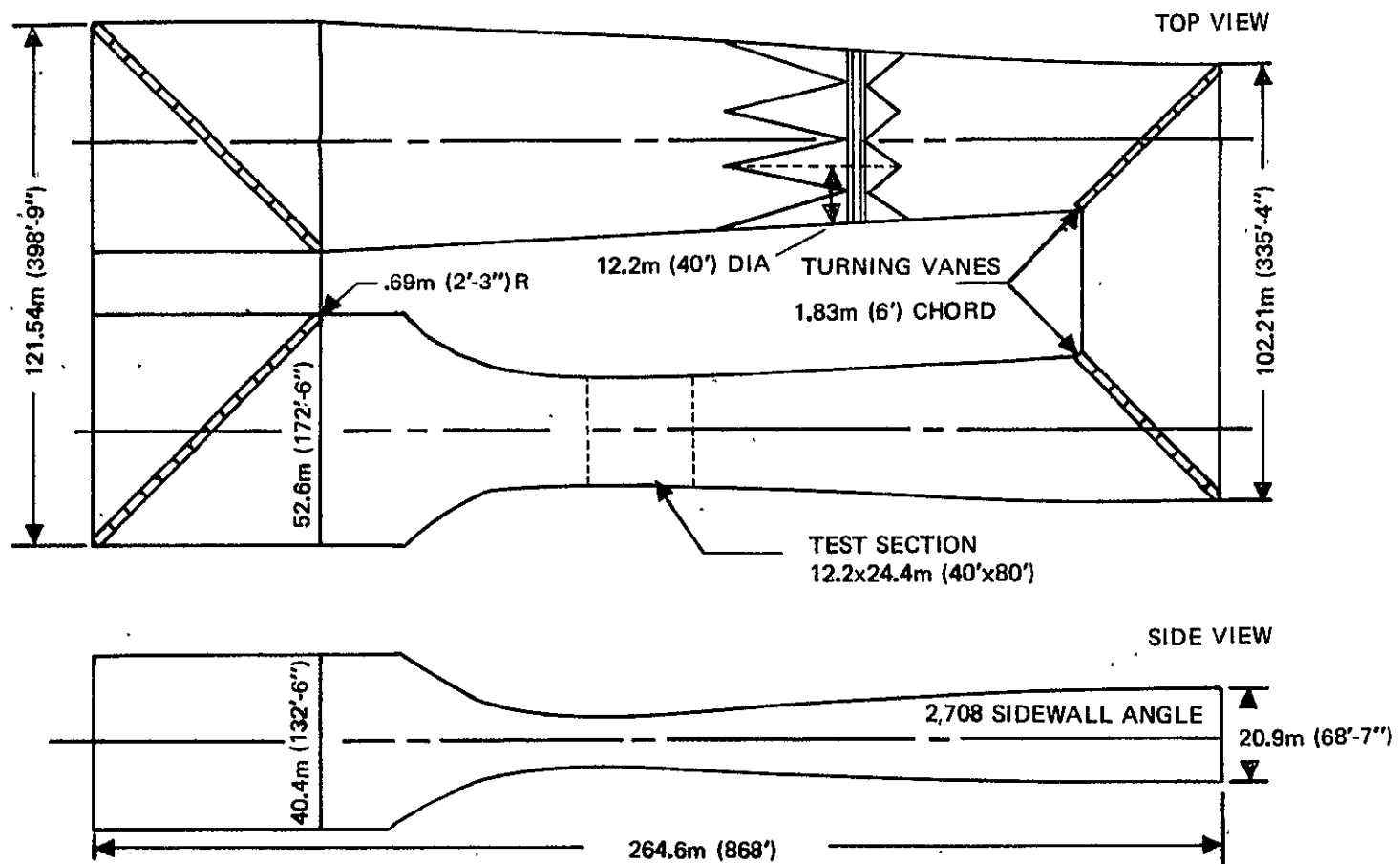


Figure 1 . Ames 40x80 Foot Wind Tunnel (12.2mx24.4m)

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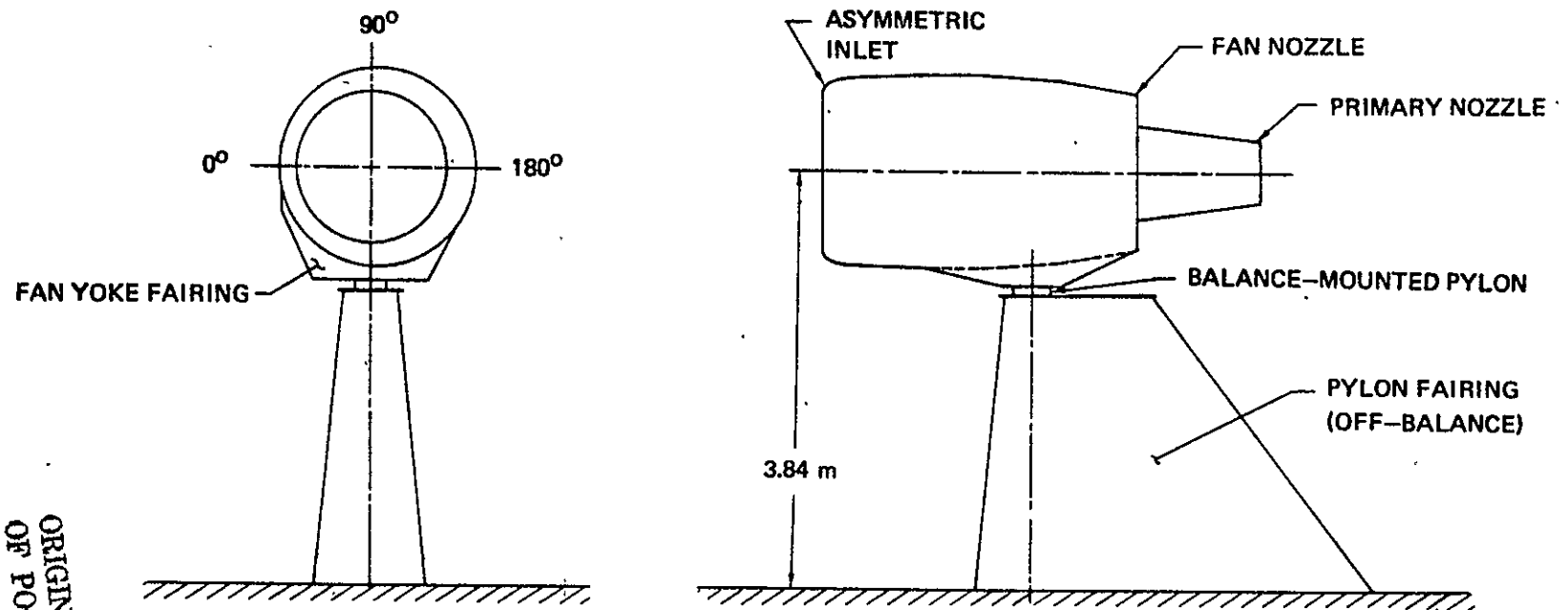
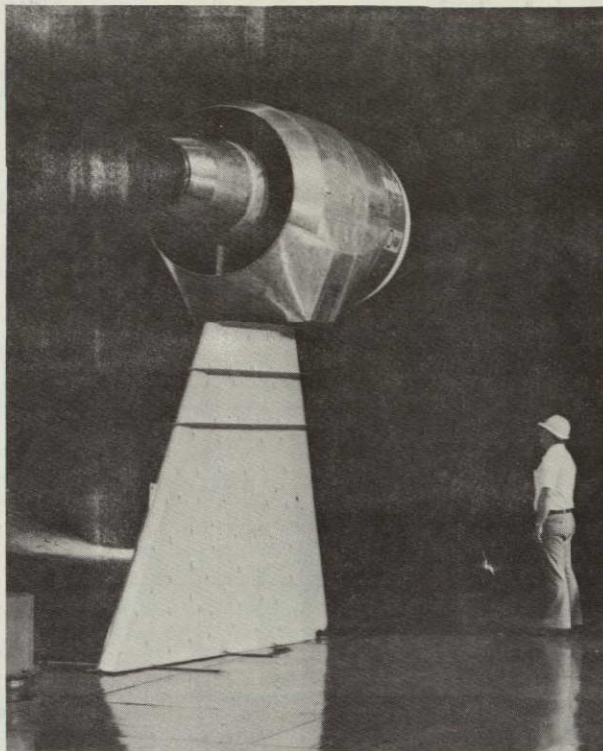
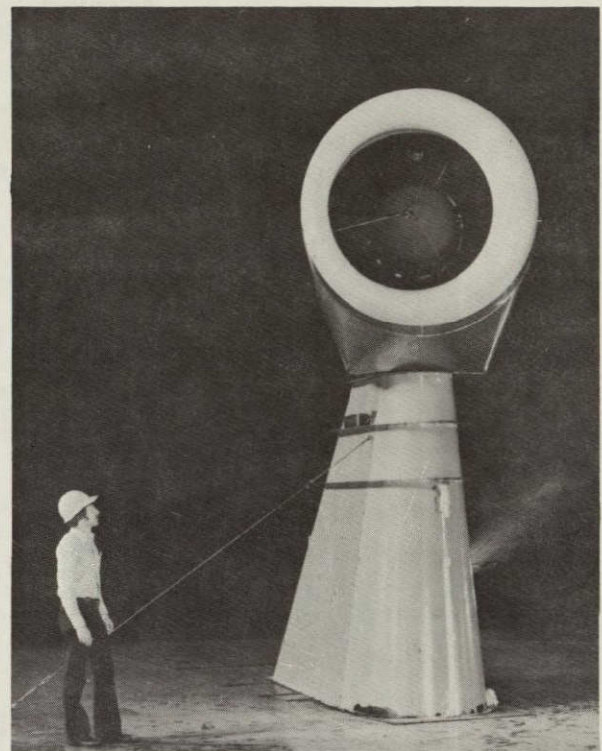


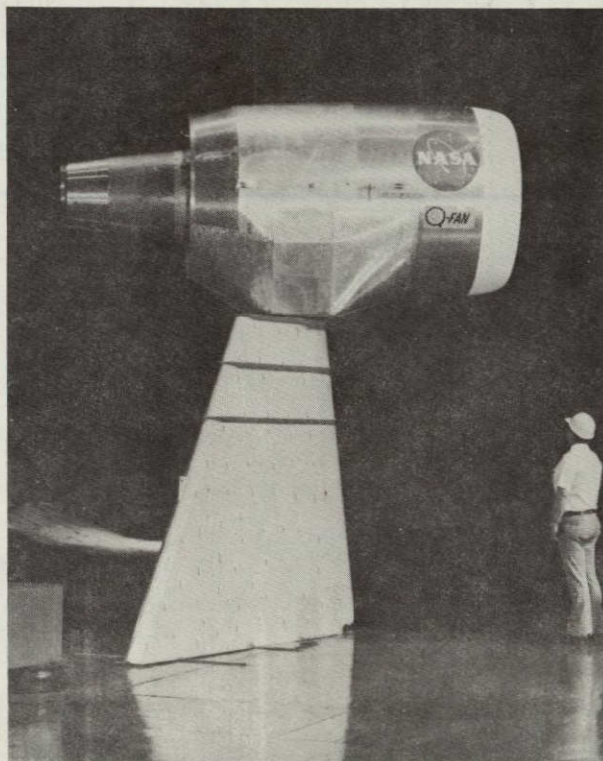
Figure 2. Wind Tunnel Installation Schematic



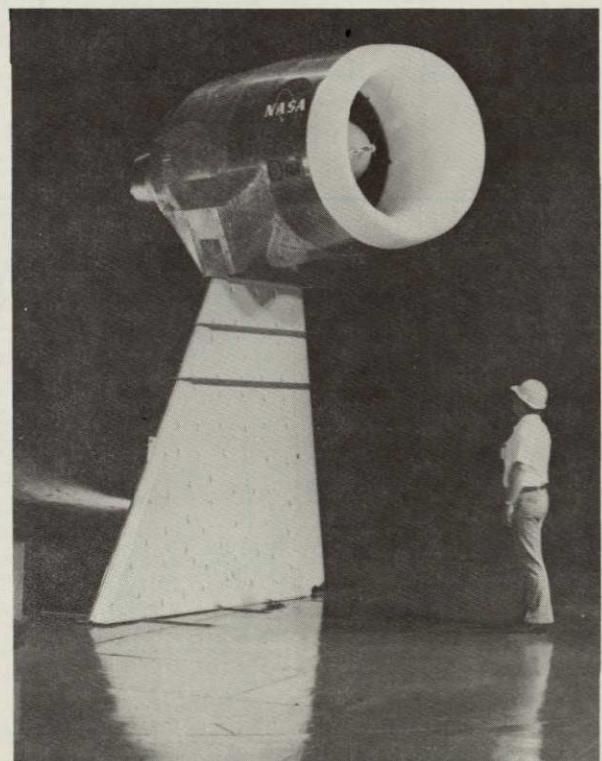
AFT VIEW $\alpha = 0^\circ$



FRONT VIEW $\alpha \cong 30^\circ$



$\alpha = 60^\circ$



$\alpha = 120^\circ$

Figure 3. Model Installation

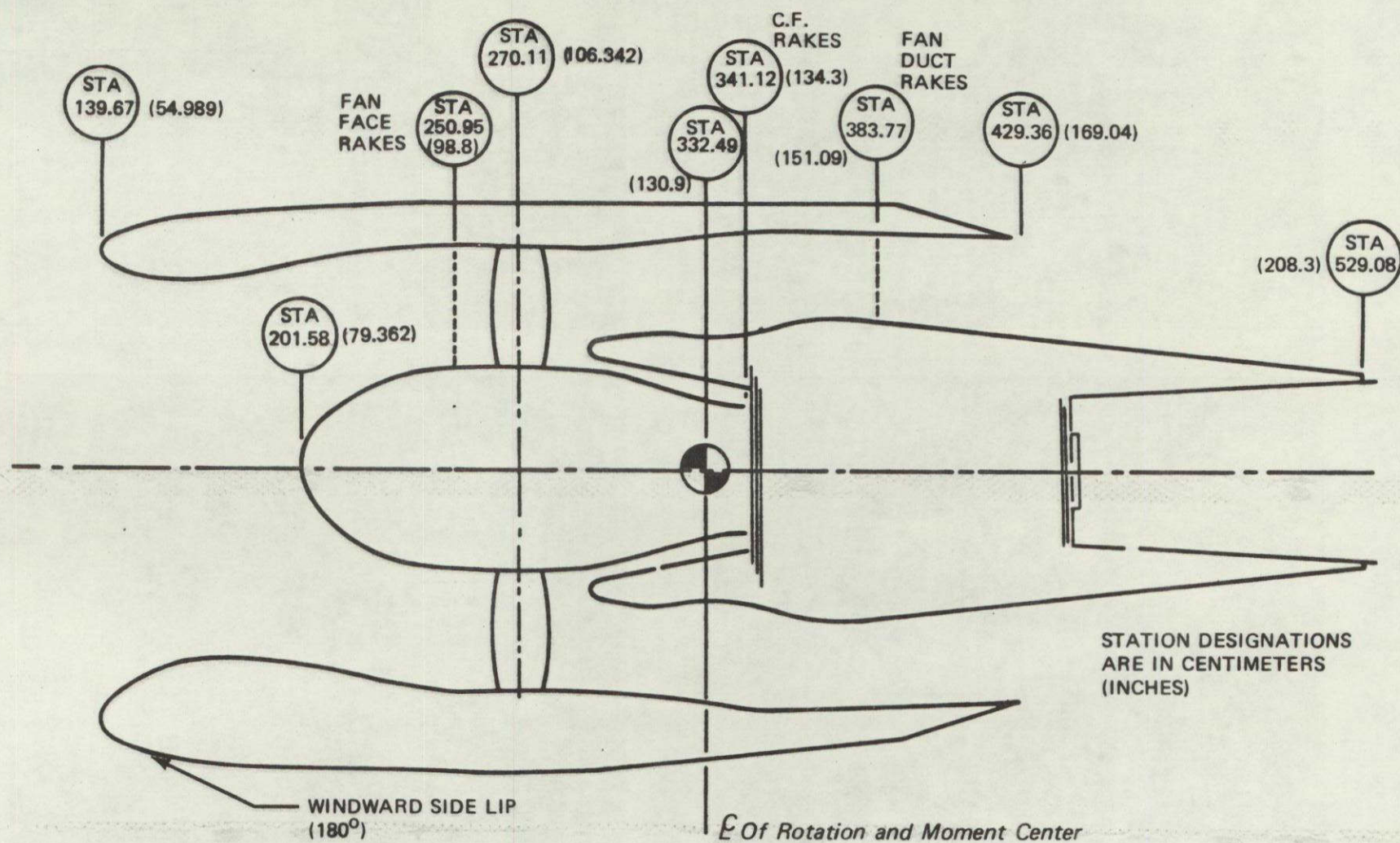


Figure 4. Nacelle Schematic

LEEWARD (0°) COWL STATIC PRESSURES				WINDWARD (180°) COWL STATIC PRESSURES				SIDE COWL STATIC PRESSURES			
P _C NO.	X/R _{FAN}	R _L /R _{FAN}	S/R _{FAN}	P _C NO.	X/R _{FAN}	R _L /R _{FAN}	S/R _{FAN}	P _C NO.	X/R _{FAN}	R _L /R _{FAN}	Θ
1	.1242	1.0650	-.1628	19	.1242	1.2602	-.1932	37	.4982	.8588	90°
2	.0466	1.0300	-.0775	20	.0466	1.2227	-.1067	38	.4982	.8588	270°
3	.0137	1.0036	-.0352	21	.0137	1.1849	-.0563				
4	.0021	.9844	-.0127	22	.0021	1.1527	-.0220				
5	0	.9719	0	23	0	1.1308	0				
6	.0007	.9640	.0079	24	.0007	1.1183	.0125				
7	.0042	.9519	.0205	25	.0042	1.0999	.0313				
8	.0109	.9399	.0343	26	.0109	1.0811	.0513				
9	.0209	.9280	.0499	27	.0209	1.0619	.0729				
10	.0500	.9057	.0865	28	.0500	1.0244	.1204				
11	.1048	.8810	.1468	29	.1048	.9781	.1923				
12	.1817	.8620	.2261	30	.1817	.9342	.2809				
13	.2987	.8524	.3436	31	.2936	.8927	.4003				
14	.4445	.8573	.4895	32	.4445	.8619	.5545				
15	.5954	.8709	.6410	33	.5954	.8524	.7058				
16	.8136	.9011	.8613	34	.8136	.8691	.9248				
17	1.0317	.9368	1.0824	35	1.0317	.9084	1.1465				
18	1.3590	.9836	1.4130	36	1.3590	.9741	1.4803				

*STEADY STATE & DYNAMIC PICKUP
(FLUSH MOUNTED KULITE, PDS)

FAN FACE COWL STATIC PRESSURES			
P _C NO.	X/R _{FAN}	R _L /R _{FAN}	Θ
39	1.5931	≅ 1.0	15.7°
40	↓	↓	67.1
41	↓	↓	118.6
42	↓	↓	170.0
43	↓	↓	221.4
44	↓	↓	272.9
45	↓	↓	324.3

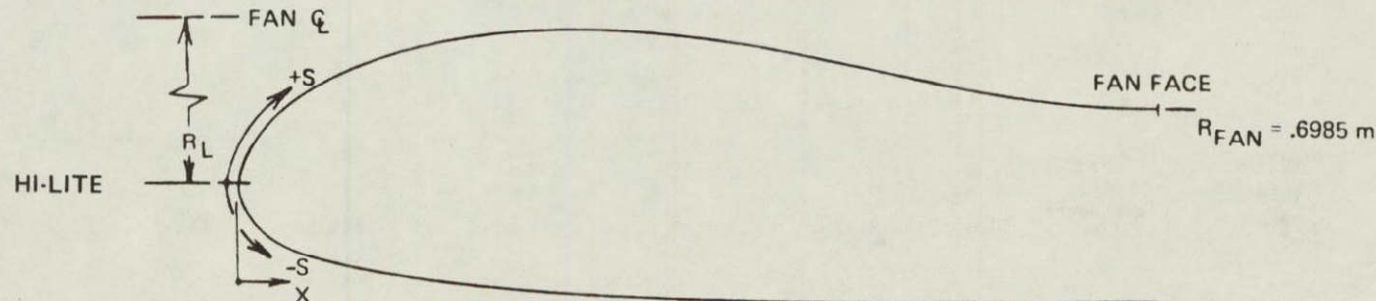


Figure 5. Cowl Static Pressure Instrumentation

FAN FACE RAKE PROBE COORDINATES AND NUMBERING

	RAKE 1	RAKE 2	RAKE 3	RAKE 4	RAKE 5	RAKE 6	RAKE 7	RING RADIUS R/R _{FAN}	% AREA FOR RING
RING 1	PTF 1	PTF 11	PTF 21	PTF 31	PTF 41	PTF 51	PTF 61	.9901	5%
RING 2	2	12	22	32	42	52	62	.9700	5%
RING 3	3	13	23	33	43	53	63	.9286	15%
RING 4	4	14	24	34 ¹	44	54	64	.8627	15%
RING 5	5	15	25	35	45	55	65	.7914	15%
RING 6	6	16	26	36	46	56	66	.7129	15%
RING 7	7	17	27	37	47	57	67	.6247	15%
RING 8	8	18	28	38	48	58	68	.5582	5%
RING 9	PTF 9	PTF 19	PTF 29	PTF 39 ²	PTF 49	PTF 59	PTF 69	.5218	5%
	PP1	PP2	PP3	PP4	PP5	PP6	PP7	.5017	--
RING 10	PTF 10	PTF 20	PTF 30	PTF 40 ³	PTF 50	PTF 60	PTF 70	.4813	5%
RAKE ANGLE (deg)	25.7	77.1	128.6	180.0	213.4	282.3	334.3		

- 1 PDF 1
- 2 PDF 2
- 3 PDF 3

Dynamic total pressure probe mounted side by side with steady state probe

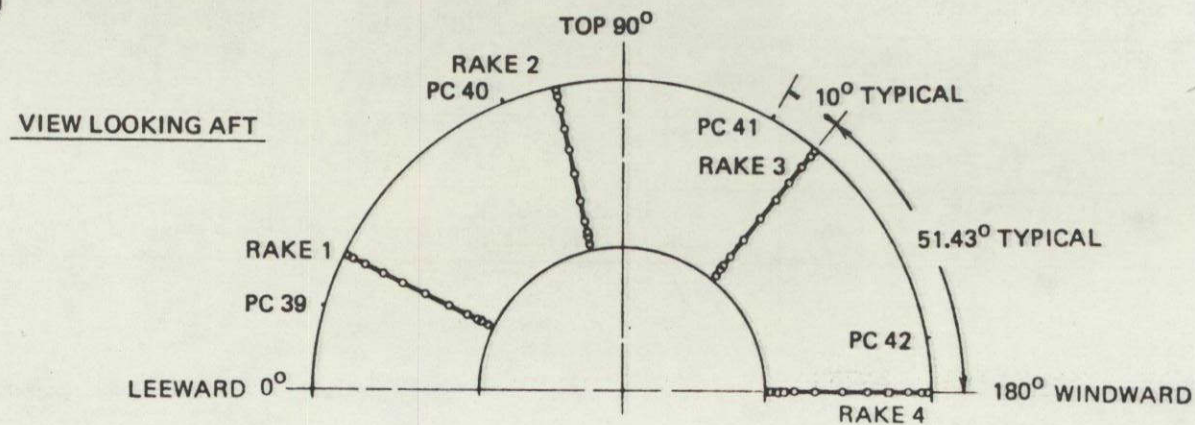


Figure 6 Fan Face Instrumentation

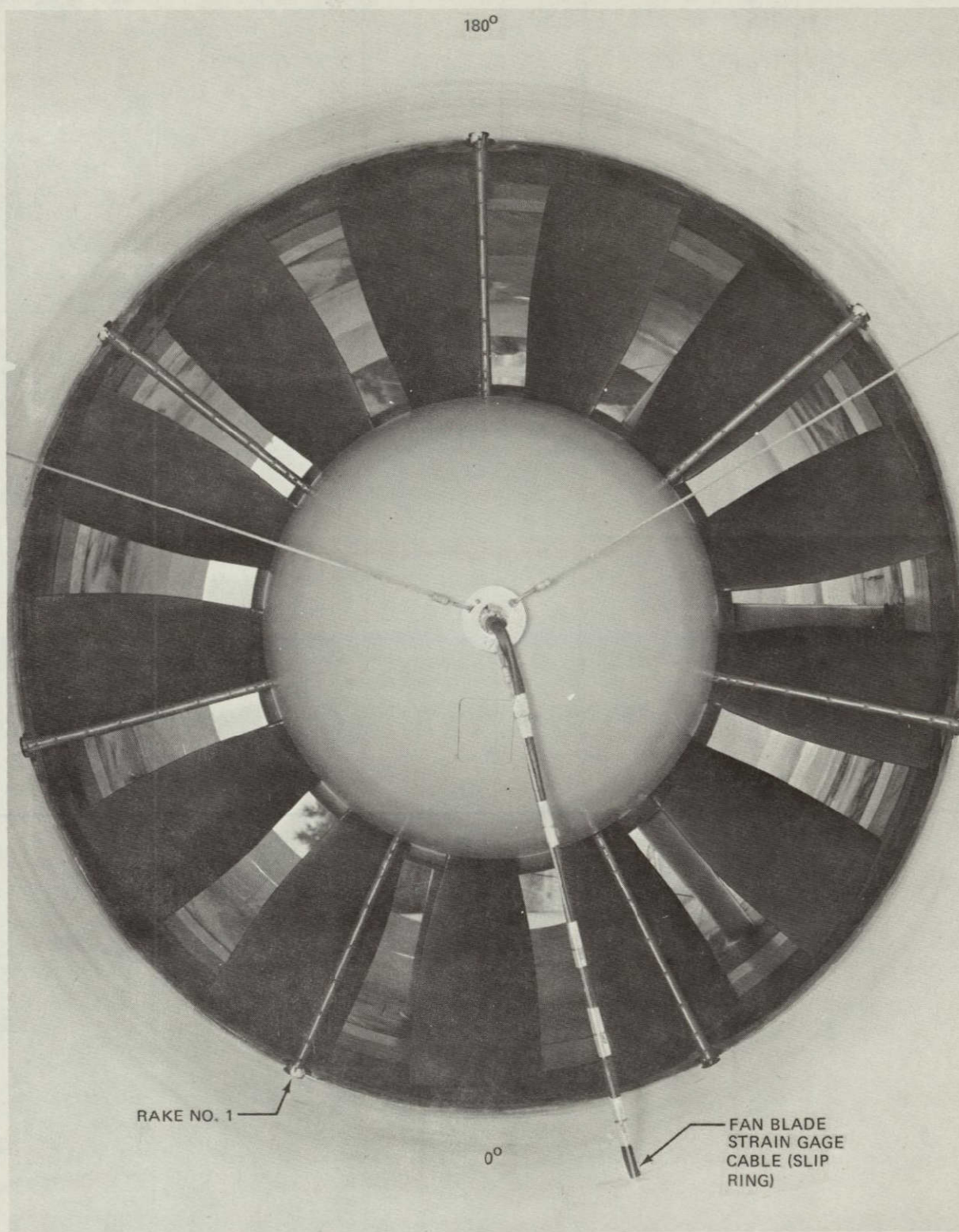


Figure 7 Fan Face (Front View)

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00 PROBES	180° PROBES	RADIUS R/R FAN	$\Delta A/AR$
NOZZLE WALL	NOZZLE WALL	1.0676	
PM1	PM3	1.0640	
PTM1	PTM11	1.0447	.142
PTM2	PTM12	.9964	.134
TTM1	TTM4	.9738	
PTM3	PTM13	.9513	.121
PTM4	PTM14	.9084	.110
PTM5	PTM15	.8676	.100
PTM6	PTM16	.8287	.091
TTM2	TTM5	.8102	
PTM7	PTM17	.7916	.083
PTM8	PTM18	.7556	.077
PTM9	PTM19	.7211	.071
TTM3	TTM6	.7044	
PTM10	PTM20	.6876	.073
CORE CASE	CORE CASE	.6676	

ΔA : Area assigned to total pressure probe

AR: Flow area at rake face = 1.064 m^2

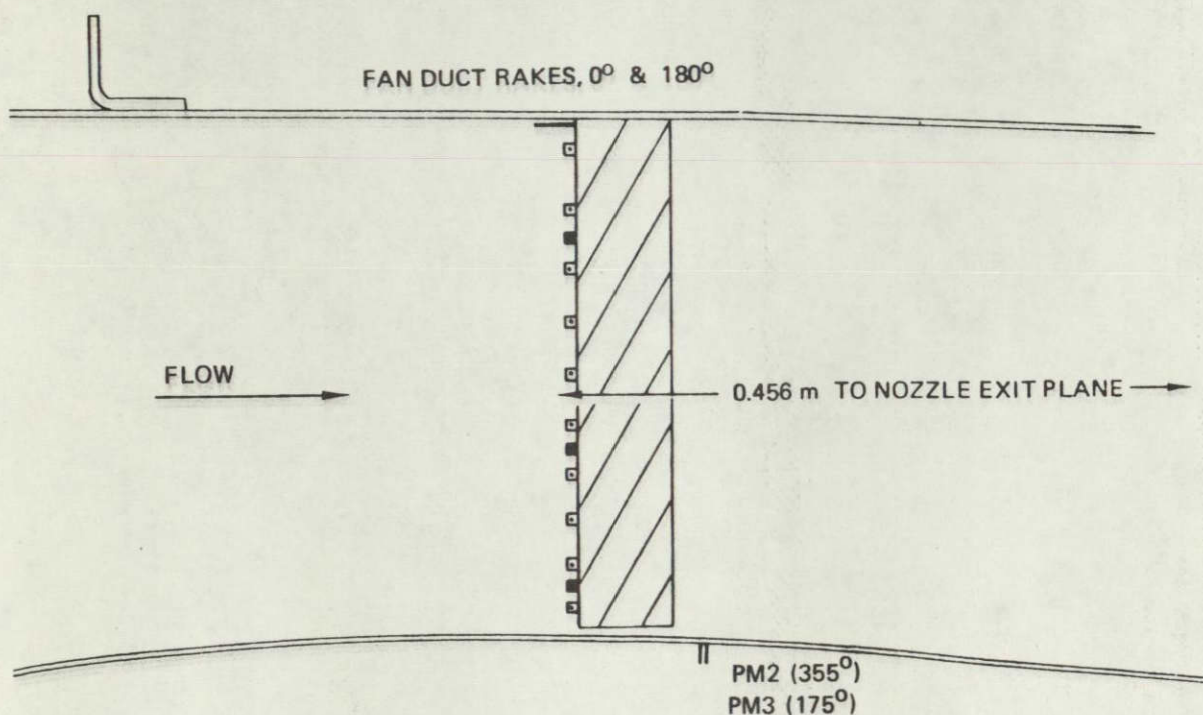


Figure 8. Fan Duct Instrumentation

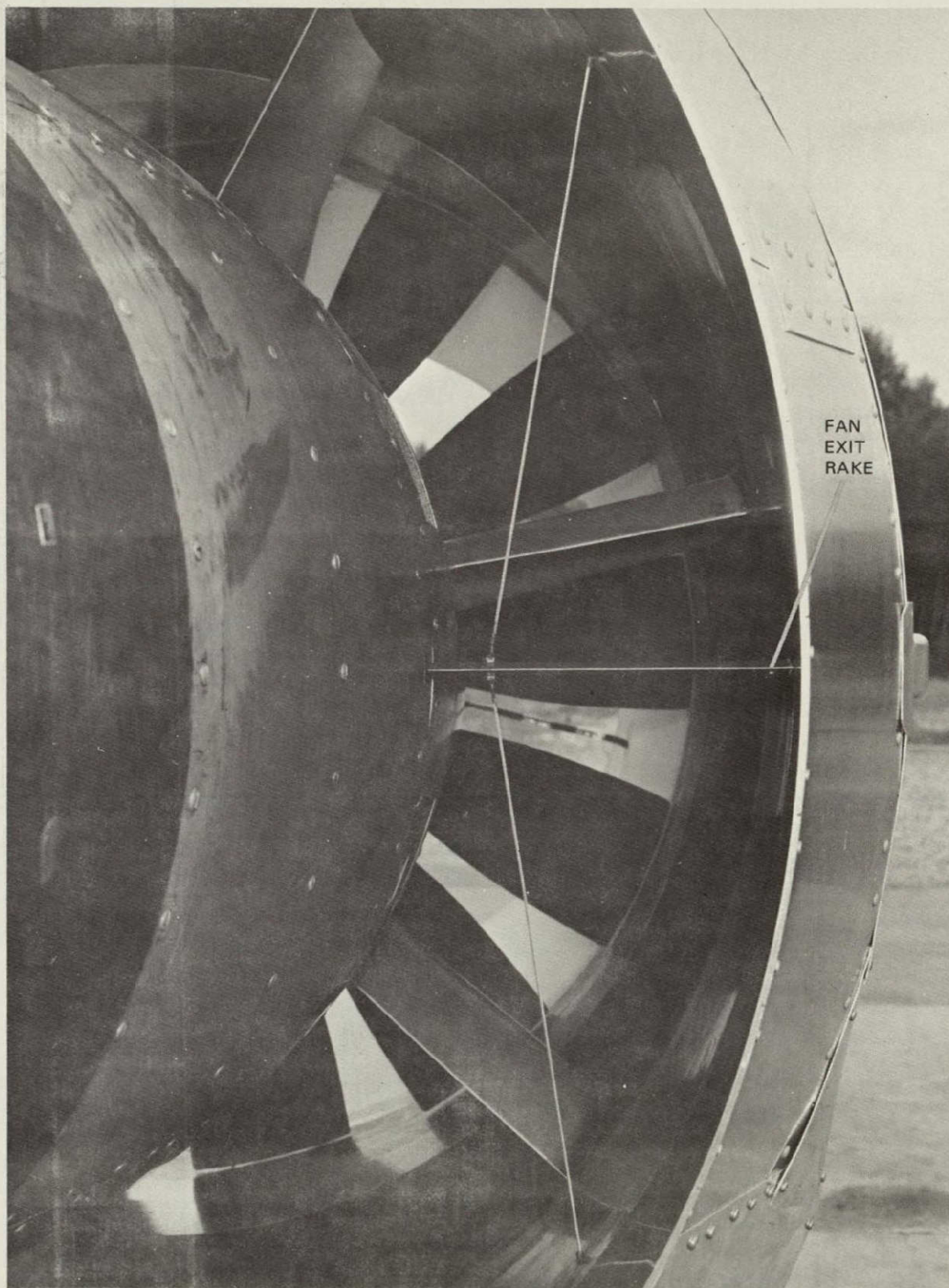


Figure 9. Aft View Fan Nozzle Exit

VIEW LOOKING FROM FRONT TO REAR

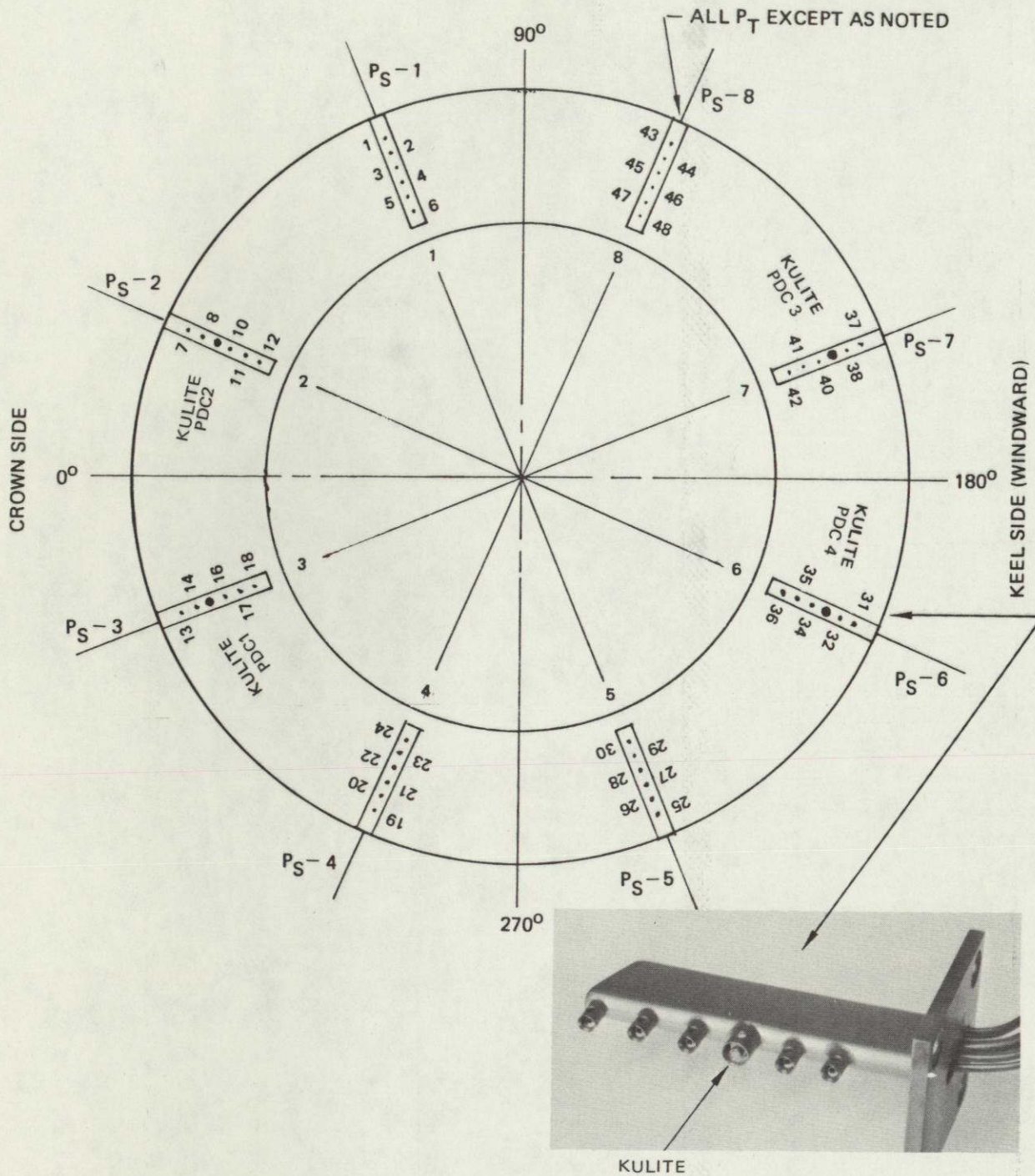


Figure 10. Compressor Face Instrumentation

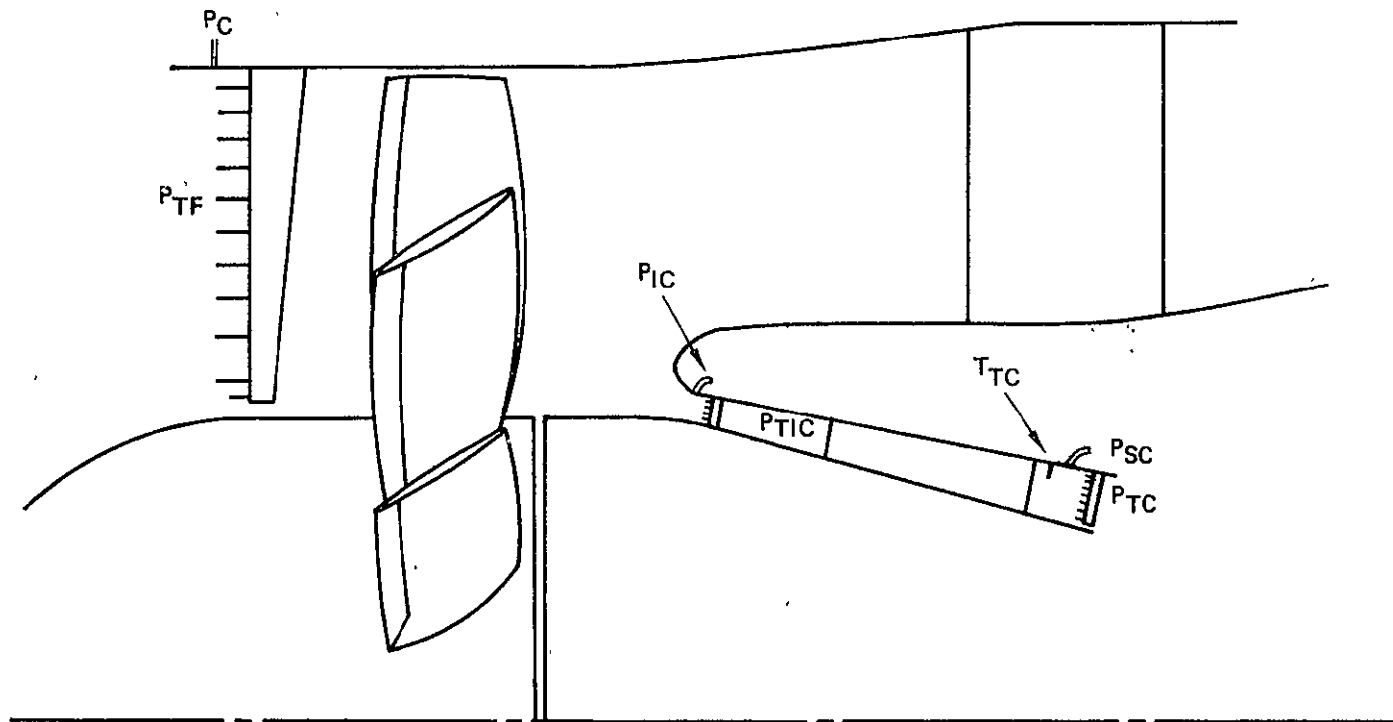


Figure 11. Core Engine Inlet Instrumentation

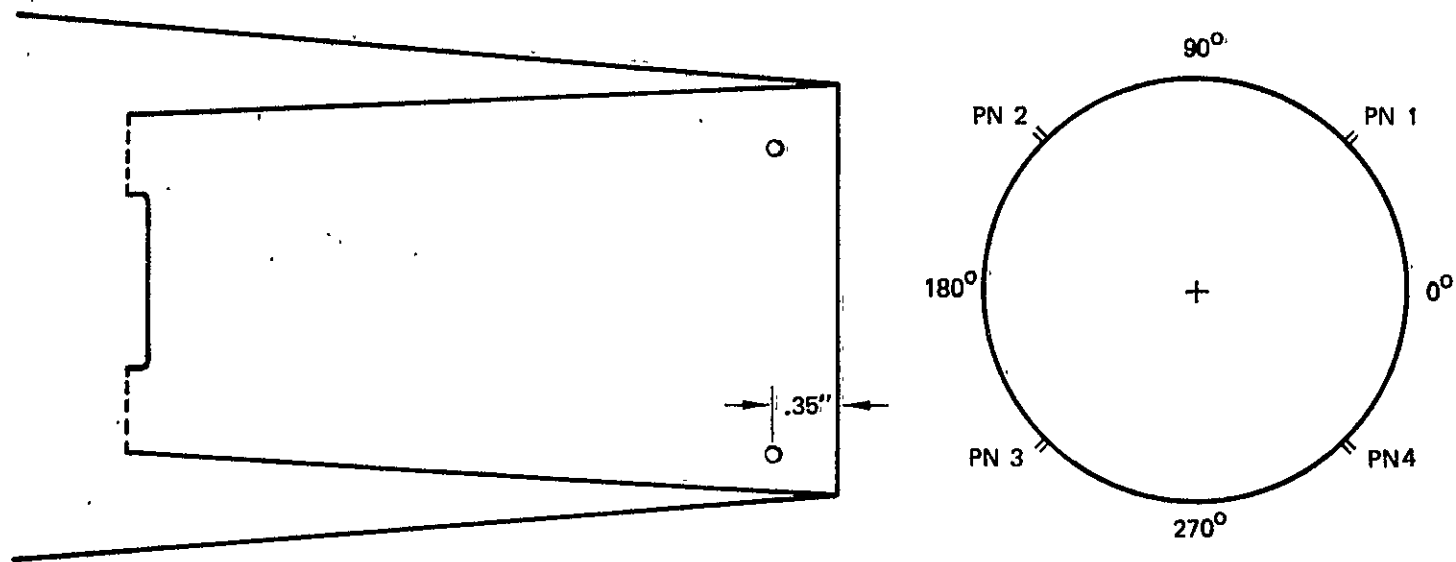


Figure 12. Core Engine Nozzle Instrumentation

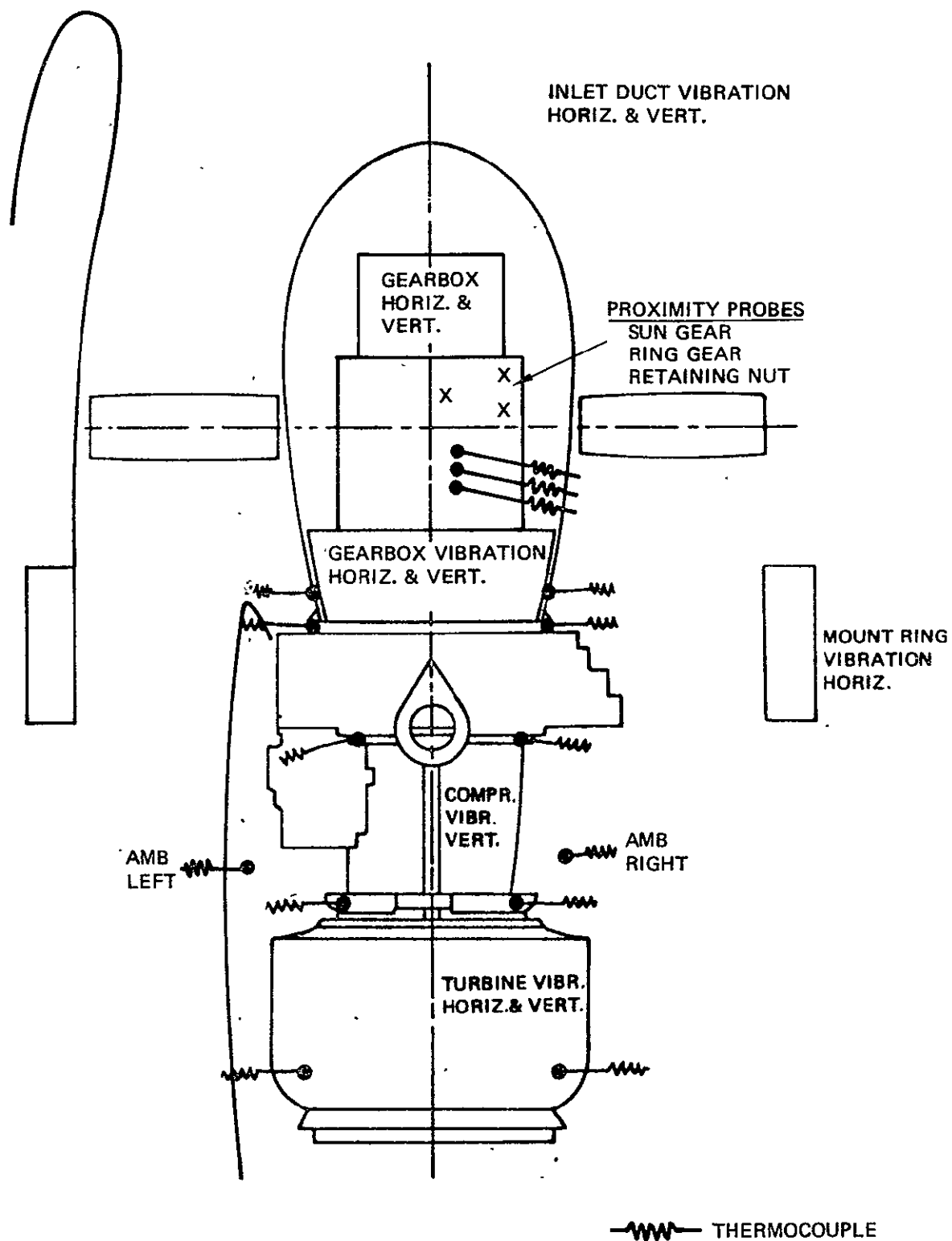


Figure 13. Nacelle Operational Health Monitoring Locations

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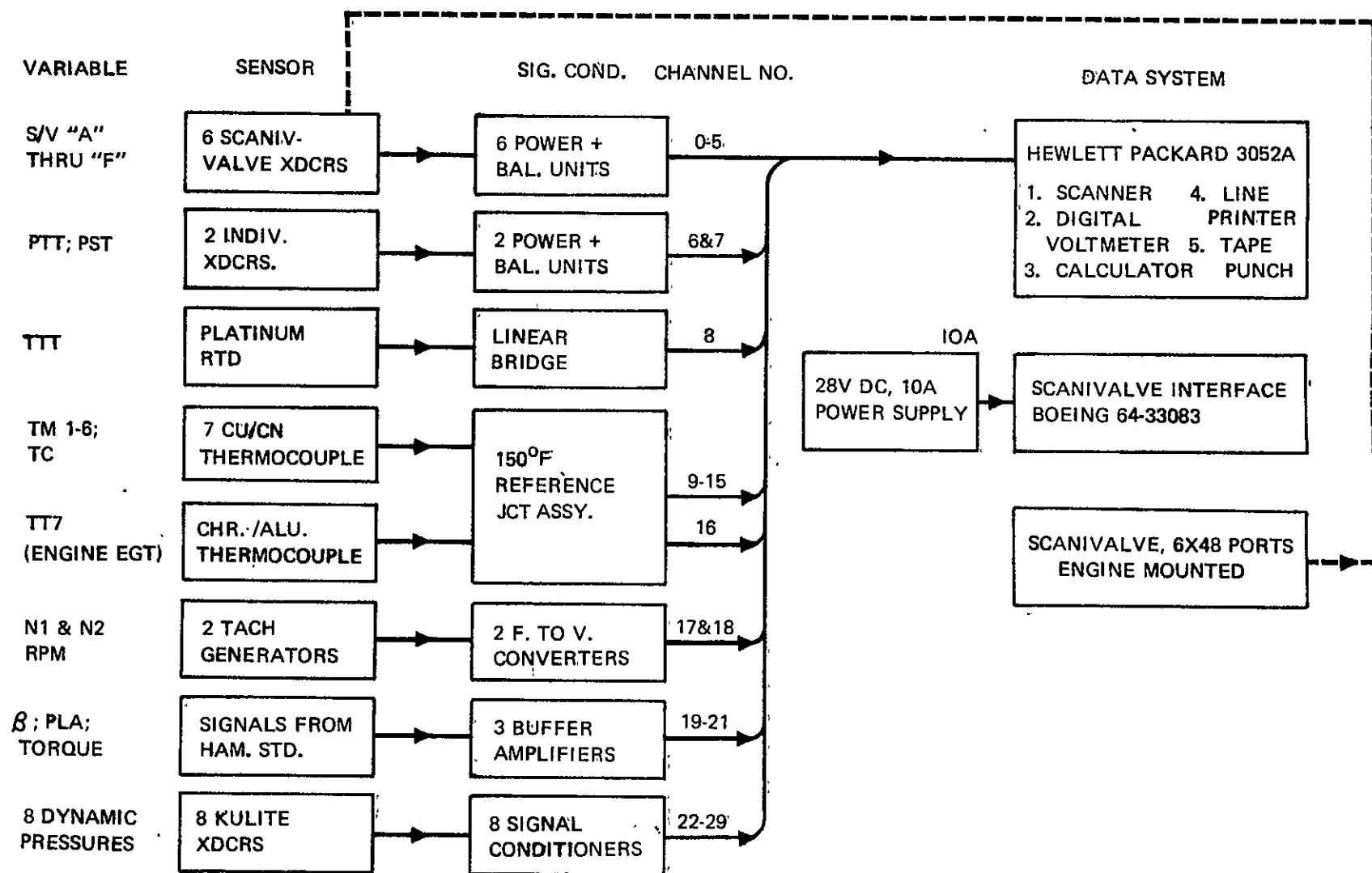


Figure 14. Block Diagram, Steady State Data Acquisition System

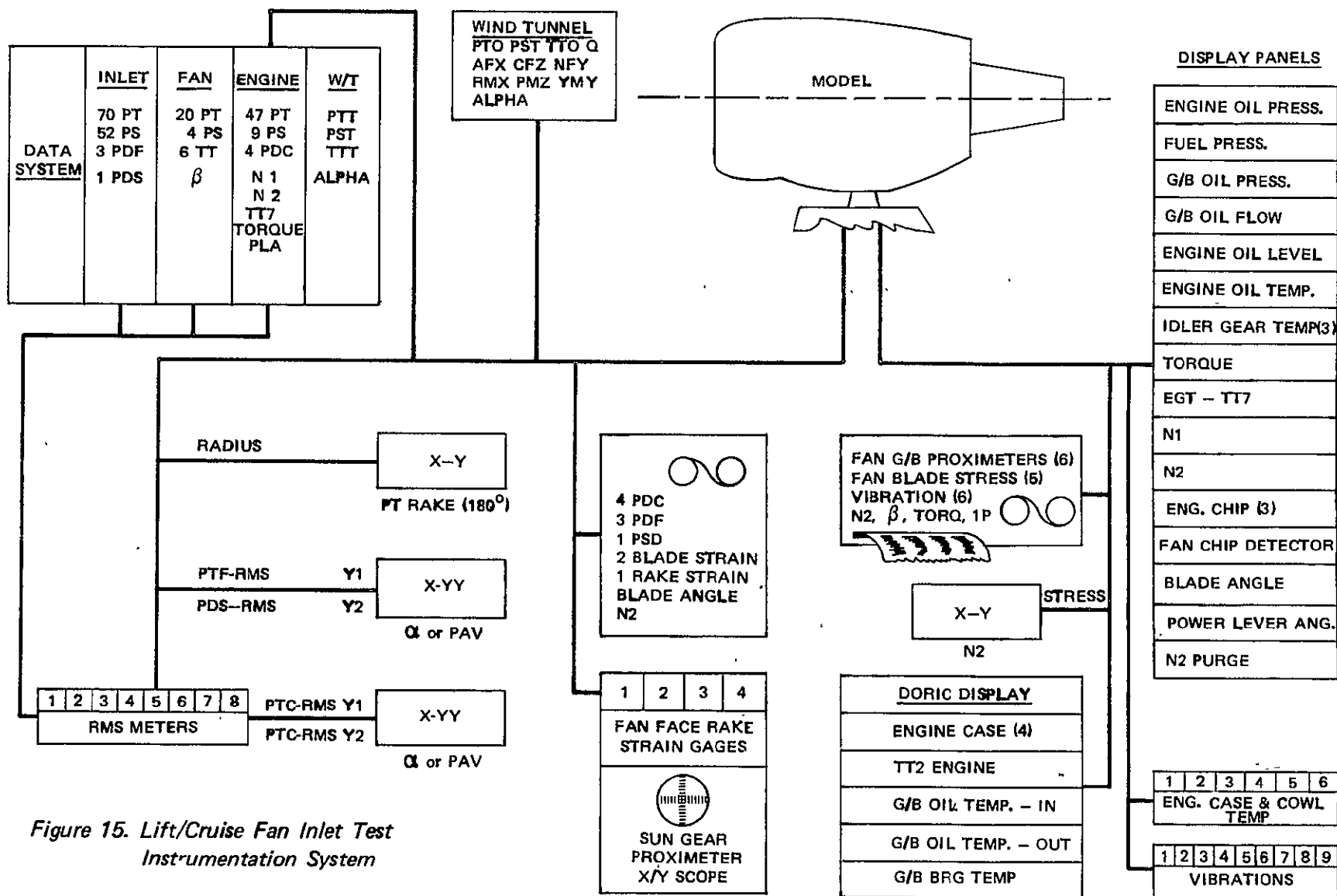


Figure 15. Lift/Cruise Fan Inlet Test
Instrumentation System

L/CFA G-FAN INLET TEST NASA-ARC 40X80 WIND TUNNEL

(1) RUN COND TEST NO. 2593, VO 0.0 ALPHA 0.00 QPSF 0.0 PTO 14.676 PD 14.676 TTO 531.0 CONF 1. DATE 91577. PBAR 14.660
 (4) WK1 103.7 (6) PTFA 0.9963 (7) DISF 0.0246 (27) FBA 117.9 (9) WKF 30.7 (28) PLA 15.8 (11) WKE 15.2 (12) PTCA 1.0013 (13) DISC 0.0212 (17) VN -0.14.682 (30) PST 14.690 TTT 528.7
 (5) W1 102.4 (19) WK2 173.8 (6a) PTFV 14.621 (21) FPR 0.998 (8) WF 30.2 (10) WE 15.0 (23) KN1 9858. (14) EP -1. (16) FN -0.1 (31) TT7 1265.8 WK1A 8.0 (4a)
 (20) W3 45.2 (18) W2 171.5 (9a) PTHAV 14.598 (22) VM 0. (10a) TTC 529.9 (24) KN2 4489. (14a) ET -1. (15) FKN -0.1

STEADY STATE RAKE PRESSURES FAN FACE

(18a) PC39 PC40 PC41 PC42 PC43 PC44 PC45 (8a) (8b) FAN NOZZLE
 (6b) PTF1 PTF11 PTF21 PTF31 PTF41 PTF51 PTF61 (8a) (8b) FAN NOZZLE
 2 12 22 32 42 52 62 PM1 PM3 (10b) PSC1 PSC 2 PSC 3 PSC4 PSC5 PSC6 PSC7 PSC8
 3 13 23 33 43 53 63 3 13 3 10 16 20 25 32 38 44
 4 14 24 34 44 54 64 4 14 4 10 16 22 27 34 40 45
 5 15 25 35 45 55 65 5 15 5 11 17 23*** 28 34 40 46
 6 16 26 36 46 56 66 6 16 PTC6 PTC12 PTC18 PTC24**** PTC30 PTC36 PTC42 PTC48
 7 17 27 37 47 57 67 7 17
 8 18 28 38 48 58 68 8 18
 9 19 29 39 49 59 69 9 19
 (18b) PTF10 PTF20 PTF30 PTF40 PTF50 PTF60 PTF70 PTM10 PTM20 (8c) TEMPERATURES FAN DUCT (29) DYNAMIC RMS
 PP1 PP2 PP3 PP4 PP5 PP6 PP7 PM2 PM4 FAN COMP
 TTM1 TTM4 PDF1 PDC1
 TTM2* TTM4 PDF2 PDC2
 TTM3 TTM6 PDF3 PDC3
 PDS PDC4

INLET COWL STATIC PRESSURES

(25a) 1) PC1 PC2 PC3 PC4 PC5
 6) 6 7 8 9 10
 11) 11 12 13 14 15
 16) 16 17 18 19 20
 21) 21 22 23 24 25
 26) 26 27 28 29 30
 31) 31 32 33 34 35
 36) 36 37 38 39 40
 41) PC41 PC42 PC43 PC44 PC45

CORE NOZZLE STATIC PRESSURES (PSIA)

(26) FORCE BALANCE
 PN1 PN2 PN3 PN4

COWL SURFACE MACH NUMBERS

(25) PC1 PC2 PC3 PC4 PC5
 PC6 same as static
 pressure array

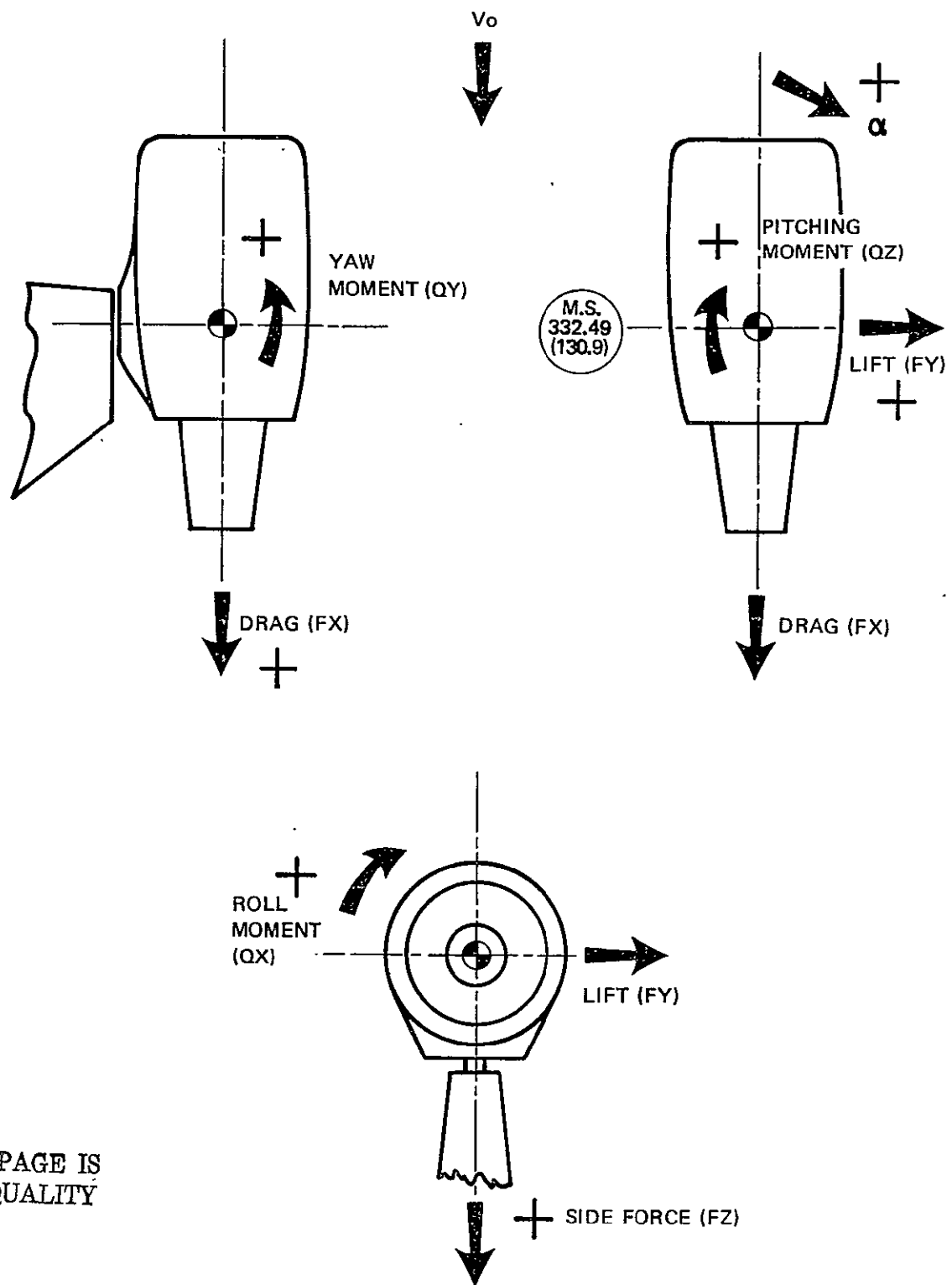
CORE INLET LIP PRESSURES

PIC 0.975 PTIC
 PTIC1
 PTIC2
 PTIC3

* Replaced with TTM3 - Runs 19 & on
 ** Replaced with PTC16 - Runs 23 & on
 *** Replaced with PTC17 - Runs 23 & on
 **** Replaced with PTC18 - Runs 23 & on

LBS FT-LBS
 FX FY FZ FXY QY QX QZ
 -549.0 -5.0 28.0 549.0 -248.0 113.0 56.0

FIGURE 16 - DATA SHEET FORMAT



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Figure 17. Nacelle Force Measurements —
Nomenclature and Sign Convention

APPENDIX A

Q-FAN DEMONSTRATOR
LIFT FAN TECHNOLOGY
BLADE STRESS REPORT

Q-FAN DEMONSTRATOR

LIFT FAN TECHNOLOGY PROGRAM

BLADE STRESS REPORT

BLADE VIBRATORY STRESSES

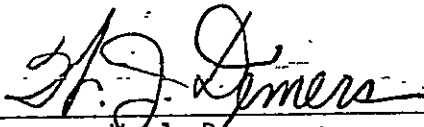
FOR

Q-FAN DEMONSTRATOR

AT

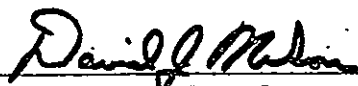
NASA AMES 40' x 80' WIND TUNNEL

Purchase Contract No. N-947295-9578
NASA Prime Contract 2-9640

Prepared by  Project Manager
W. J. Demers

 Project Engineer
D. P. Currie

 Head of Applied Mechanics
Dr. Robert W. Cornell

Reviewed by:  Program Manager
D. J. Nelson

Prepared for: Boeing Aerospace Company, Seattle, Washington

SUMMARY

The Hamilton Standard QFT-55 full scale Q-Fan Demonstrator propulsor was utilized by Boeing Aerospace Company to fabricate a large scale variable pitch Lift/Cruise fan nacelle. The unit was tested in 1976 at Boeing's Tulalip, Washington static test facility and the NASA Ames 40' x 80' wind tunnel under a NASA Prime Contract NAS2-9215. A Blade Stress Report covering those tests was submitted to Boeing on 16 November 1976.

This report covers the more recent tests which were conducted in the NASA Ames 40' x 80' Wind Tunnel during September-October 1977 under the NASA Prime Contract NAS2-9640. These tests included operation at higher nacelle tilt angles and free stream velocities than those tested in 1976.

TEST DESCRIPTION

In connection with the Boeing-NASA V/STOL aircraft program, blade vibratory stresses were measured during the testing of the Hamilton Standard Q-Fan Demonstrator in the NASA Ames 40' x 80' wind tunnel. This document reports on the results of these measurements.

The rotating components of the test unit were identical to those described in Report NAS CR-121265 (HSER 6163) which covered the stresses as measured at Hamilton Standard. Referring to Figure 6 (Pg. 239) of that report or Figure 1 included in the appendix of this report, stresses were measured using the bending strain gages located at 362 mm (14.25 in.) from the blade tip on Blades No. 1, 6 and 7 and the vee strain gages located at 89 mm (3.5 in.) from the blade tip on blades 2 and 9 during this test program. These stress measurements were recorded on magnetic tape and played back onto Sanborn records. Also recorded and played back were torque, fan speed and fan blade angle. Wind tunnel air speed, fan angle of attack (actually yaw inflow angle) and the power lever angle (PLA) were noted on the test log. An X-Y plotter was also used to record Blade No. 1 bending stress vs. N_2 (engine rpm). A number of the recordings were played back to determine the dominant frequencies of the vibratory stressing at this gage location.

The tests were conducted on the 15th thru the 21st Sept. 1977 and the 13th thru 15th October 1977. The interruption in testing was caused by an unscheduled shutdown of the wind tunnel.

Tunnel wind speeds set during the tests were 0, 40, 60, 75, 90, 105, 125, 140 and 160 knots. Inflow angles (yaw angles) were varied from 0° to 120°. The maximum fan speed and fan blade angle were 3250 RPM and 56° respectively.

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TEST RESULTS

Bending stresses were generally acceptable using a continuous limit of $+ 38 \text{ MN/m}^2$ ($+ 5500 \text{ psi}$) observed for these tests. This level was slightly exceeded when operating at combinations of angle of attack, tunnel speed and torque that produced flow separation at the duct inlet. This was evident in Test Points 27 and 31.

Bending stresses also became significant when operating near a first flatwise (1f) mode critical speed; that is, where the aerodynamic excitation at a multiple (nF) of the fan speed is near the first flatwise natural bending frequency of the blade. A critical speed diagram is shown in Figure 2. This diagram is also shown on Figure 5-39 of Report NASA CR-121265 (HSER 6163). This type of stressing was particularly evident in Test Points 30 with a maximum duct angle of attack of 120° . For instance, Test Point 30.2 showed moderate 2F/1f response at 3250 RPM and Test Point 30.7 showed significant 3F/1f response at 2300 RPM. This stress behavior was also evident in previous running of this Q-Fan.

Maximum shear stressing measured was 10.0 MN/m^2 ($+ 1450 \text{ psi}$) occurring during operation at maximum power with a maximum duct angle of attack of 120° . This amplitude of shear stressing is acceptable.

Appended to this report are copies of the on-line X-Y plots relating Blade No. 1 total vibratory stress ($+ \text{psi}$) at 362 mm (14.25 in.) from the tip and the power turbine speed, N2. To obtain the fan speed, the N2 speed is divided by the 4.75 gear ratio. Marked on these plots are the freestream tunnel velocity, V; duct angle of attack, α , (actually a yaw angle in the tunnel); fan blade angle, β , at the 75% blade radius station; date of the test, and the Run Number (same as Test Point Number) designated by Boeing. The sequence of the testing, which at times influenced the stressing, was in the order of increasing Run Number.

Twenty-four such plots are given. (Not all of the runs are shown on these plots). The 43° blade angle points for Boeing Run Nos. 13 and 25 show moderate stressing. Likewise, stressing is moderate for Run No. 30. All of these conditions are at combinations of high duct angle of attack, tunnel speeds of 39 m/s (75 knots) or less, and comparatively low torque. In addition, the stress peaks generally occur near the N2 speed of 10,000 RPM, corresponding to a fan speed of about 2100 RPM. Inlet flow separation is believed to have occurred during the deceleration for Boeing Run No. 13.

Also given in the Appendix are six pages summarizing the stresses measured during the testing. These tables were prepared from the Sanborn playbacks. Identification of the test condition is given by the HS Run No. correlated with the Boeing Test Point No. Maximum bending stresses were noted during Test Points Nos. 27, 30, and 31. As above, the points for Nos. 27 and 30 were at combinations of high angle of attack, moderate tunnel speeds, and low torque. Test Points for No. 31 were unique in that this is the only run in which the variable was the duct angle of attack. Tunnel speed and fan power were kept constant. Upon increasing angle of attack, significant stressing occurred only as the maximum angle of 80° was approached. This stressing was maintained until an angle of less than 78° was reached. This hysteresis may be a characteristic of duct inlet separation.

Test Results (continued)

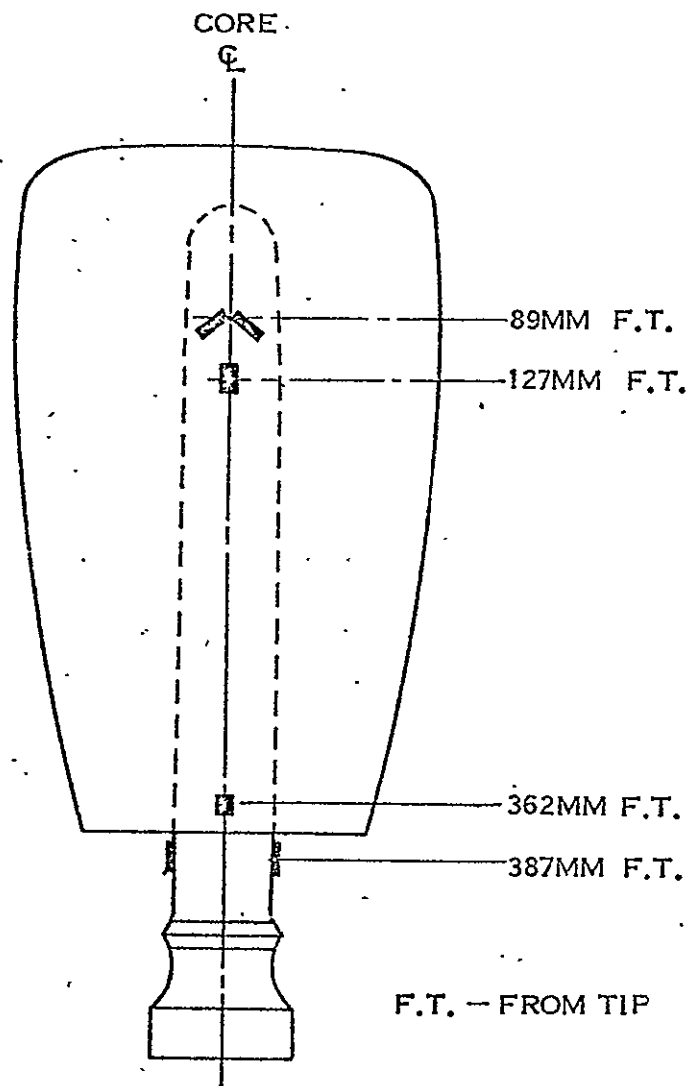
The Appendix also includes 15 frequency spectrum plots for conditions selected from the stress tabulations. These results confirm that the major bending stress response is at frequencies which are integer multiples of the fan speed - $1F$, $2F$, $3F$, etc. Stressing can become significant when one of these frequencies is near the blade natural frequency just above 100 Hz. Test Point 30.7, for instance, shows predominant response near 112 Hz. This is the $3F/1f$ condition. Likewise, Test Points 30.1 and 30.2 show moderate stressing near 105 Hz. This is the $2F/1f$ condition.

These frequency spectrum plots also show stress response in the first flat-wise natural bending mode when this frequency is not an integer multiple of the fan speed. This response was evident, for instance, for Boeing Test Points 27.5, 31.4, and 31.5. It was also evident in Points 27.6 and 27.8 where the response was very close to but not exactly at the $3F$ frequency. This type of response could very well be caused by turbulence associated with duct inlet separation.

In summary, the vibratory stress levels measured in this investigation were acceptable. No significant structural fatigue damage accrued from these tests. Major stress response was due to the proximity of a frequency of aerodynamic excitation to the first natural blade bending frequency. This type of response was evident in previous tests of this Q-fan. Some stress response was noted in the first natural bending mode at a frequency not equal to an integer multiple of the fan speed. This response would be expected from the turbulent nature of the air flow associated with separation within the duct.

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APPENDIX
TO
Q-FAN DEMONSTRATOR
LIFT FAN TECHNOLOGY PROGRAM
BLADE STRESS REPORT



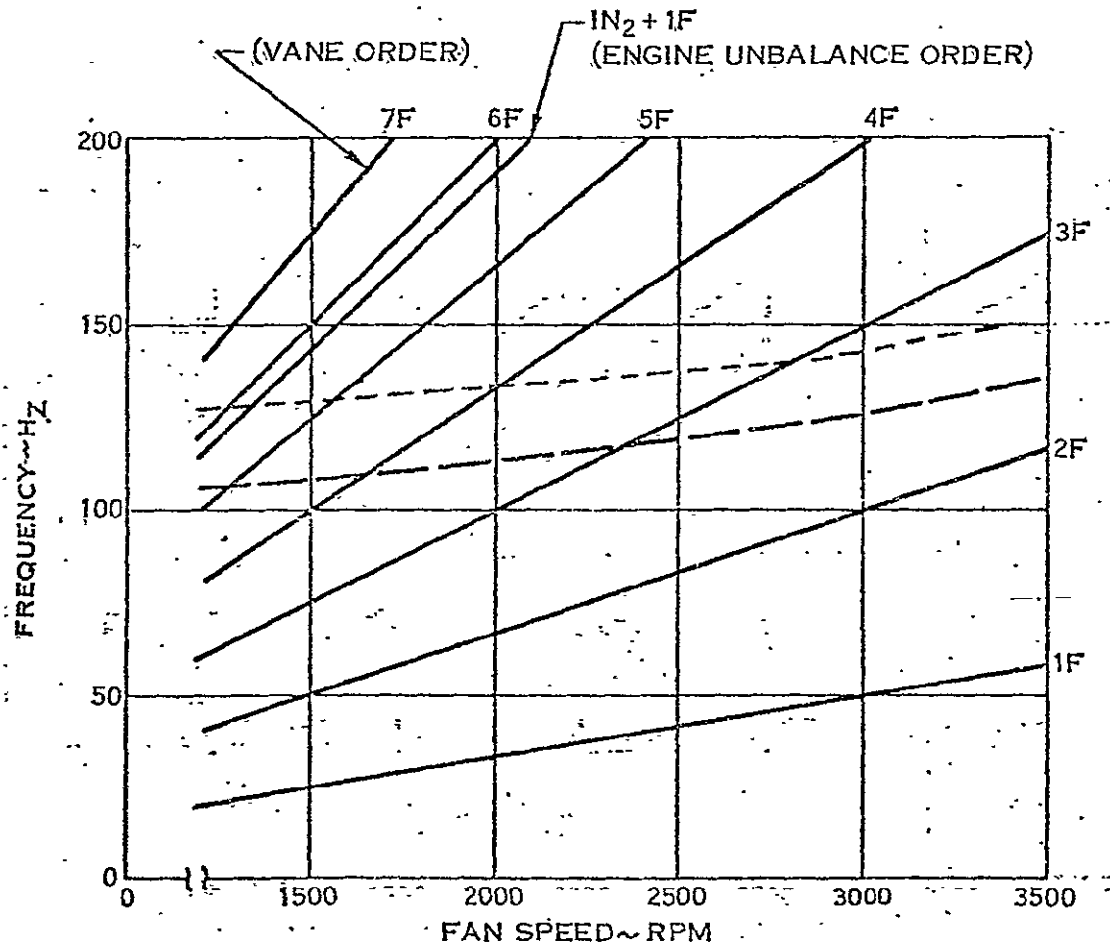
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FIGURE 1

APPROXIMATE FREQUENCY
OF FIRST FLATWISE BLADE MODE
IN FORWARD THRUST

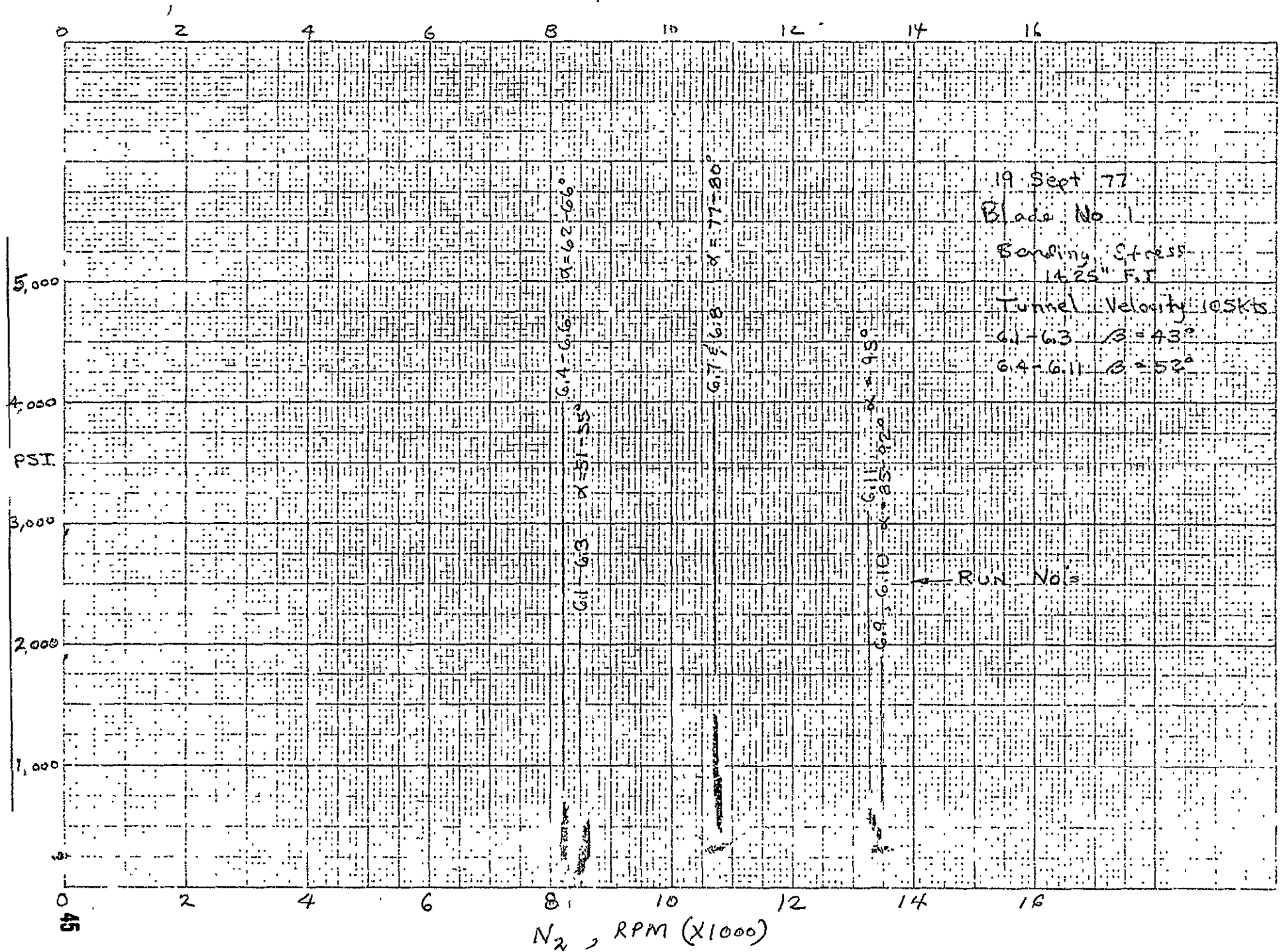
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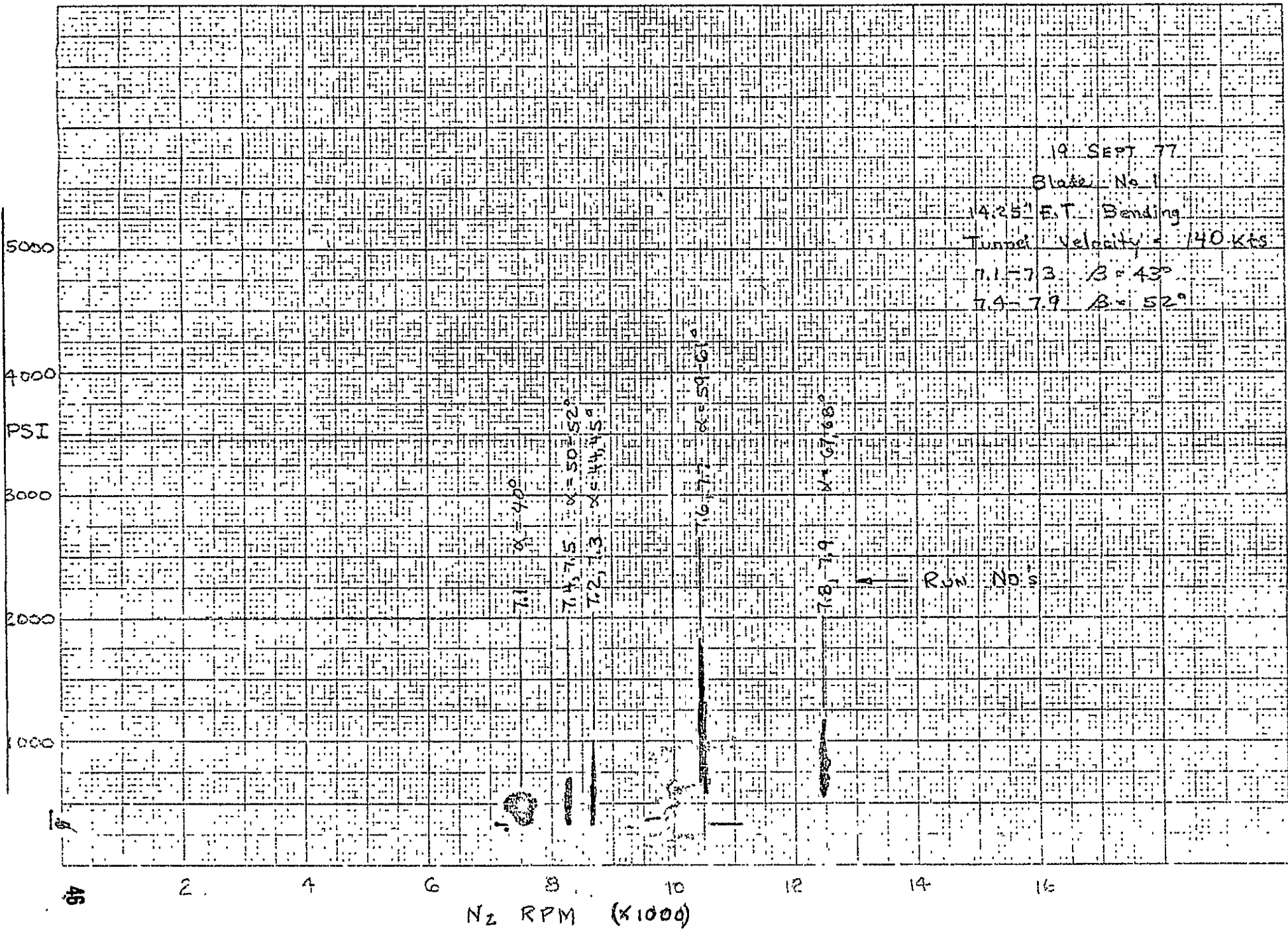
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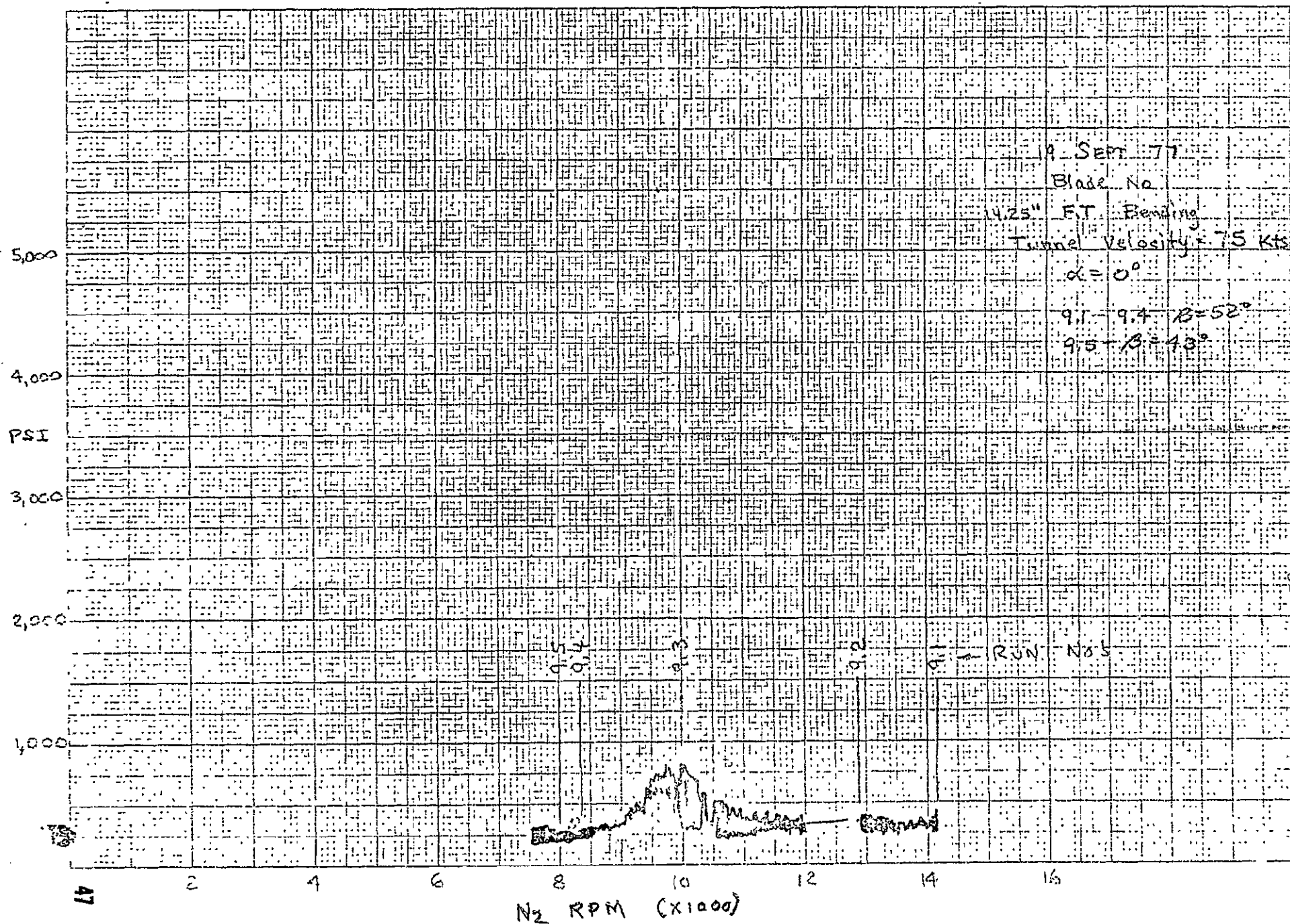


1.4 M DIAM. Q-FAN DEMONSTRATOR
CRITICAL SPEED DIAGRAM

FIGURE 2







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Blade No 1

19.25" F.T. Bending

Tunnel Velocity = 75 Kts

$\alpha = 60^\circ$

10.1 - 10.4 $\beta = 52^\circ$

10.5 $\beta = 43^\circ$

Row No 5

N₂ RPM (X1000)

5,000

4,000

PSI

3,000

2,000

1,000

0

46

2

4

6

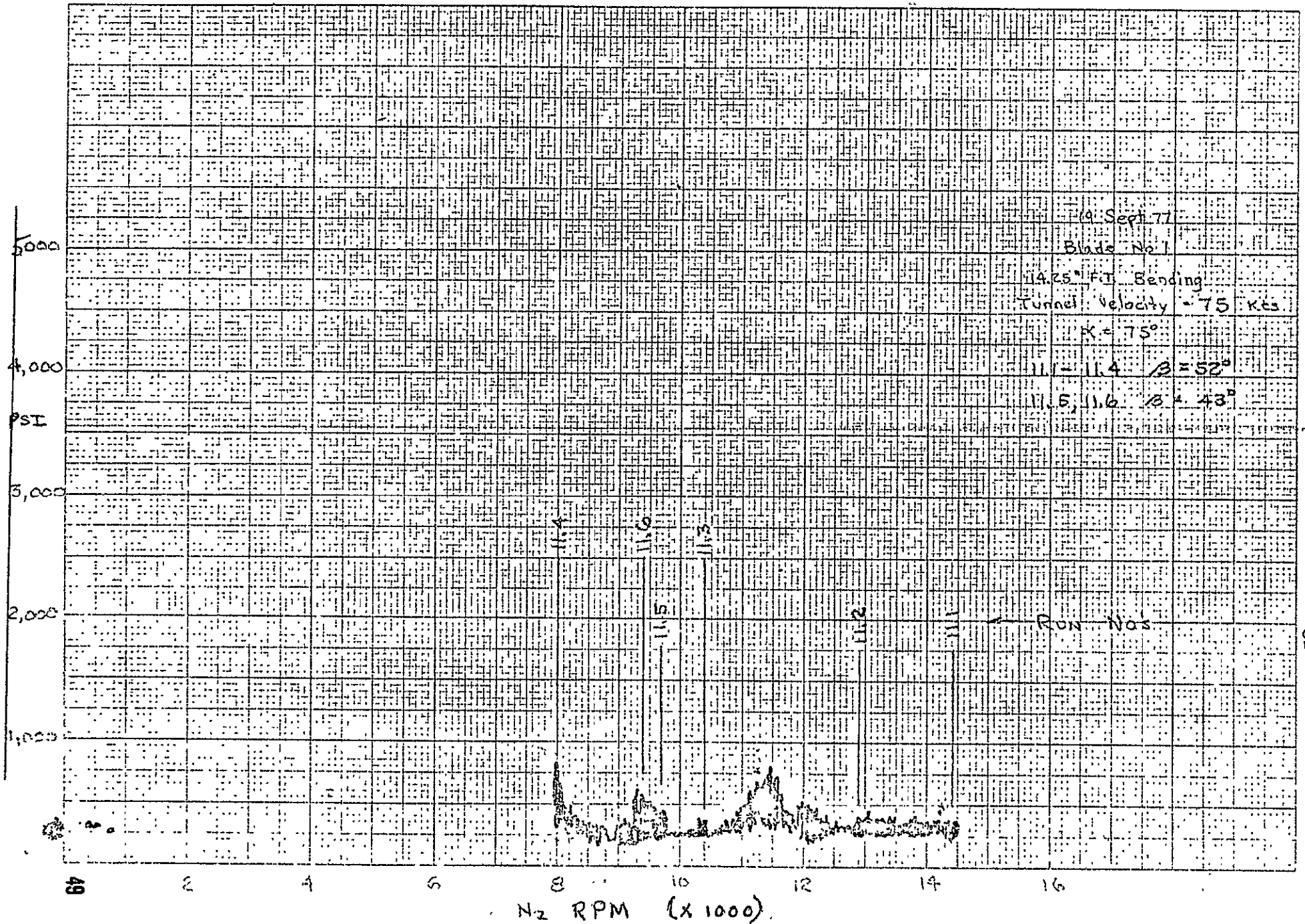
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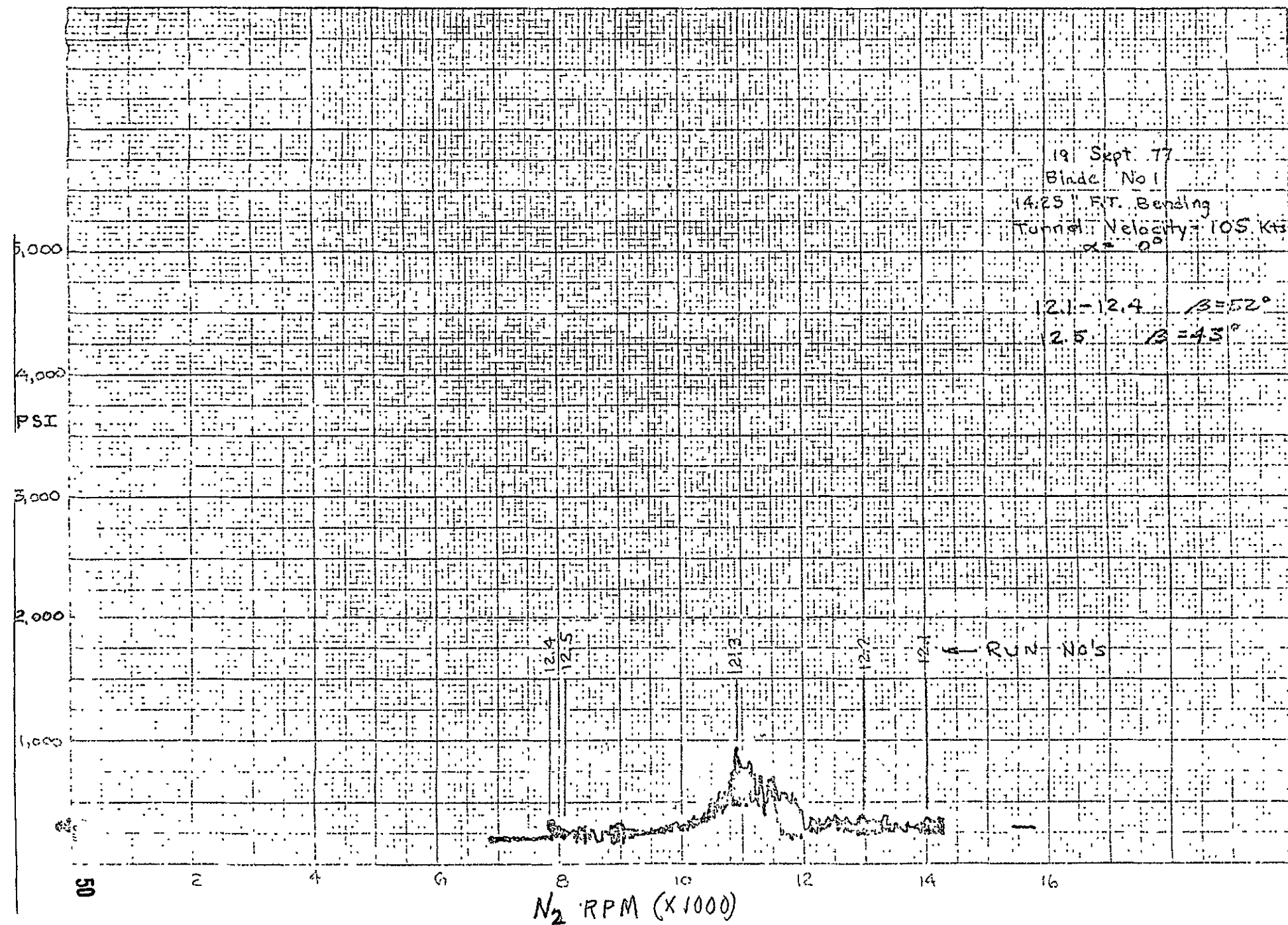
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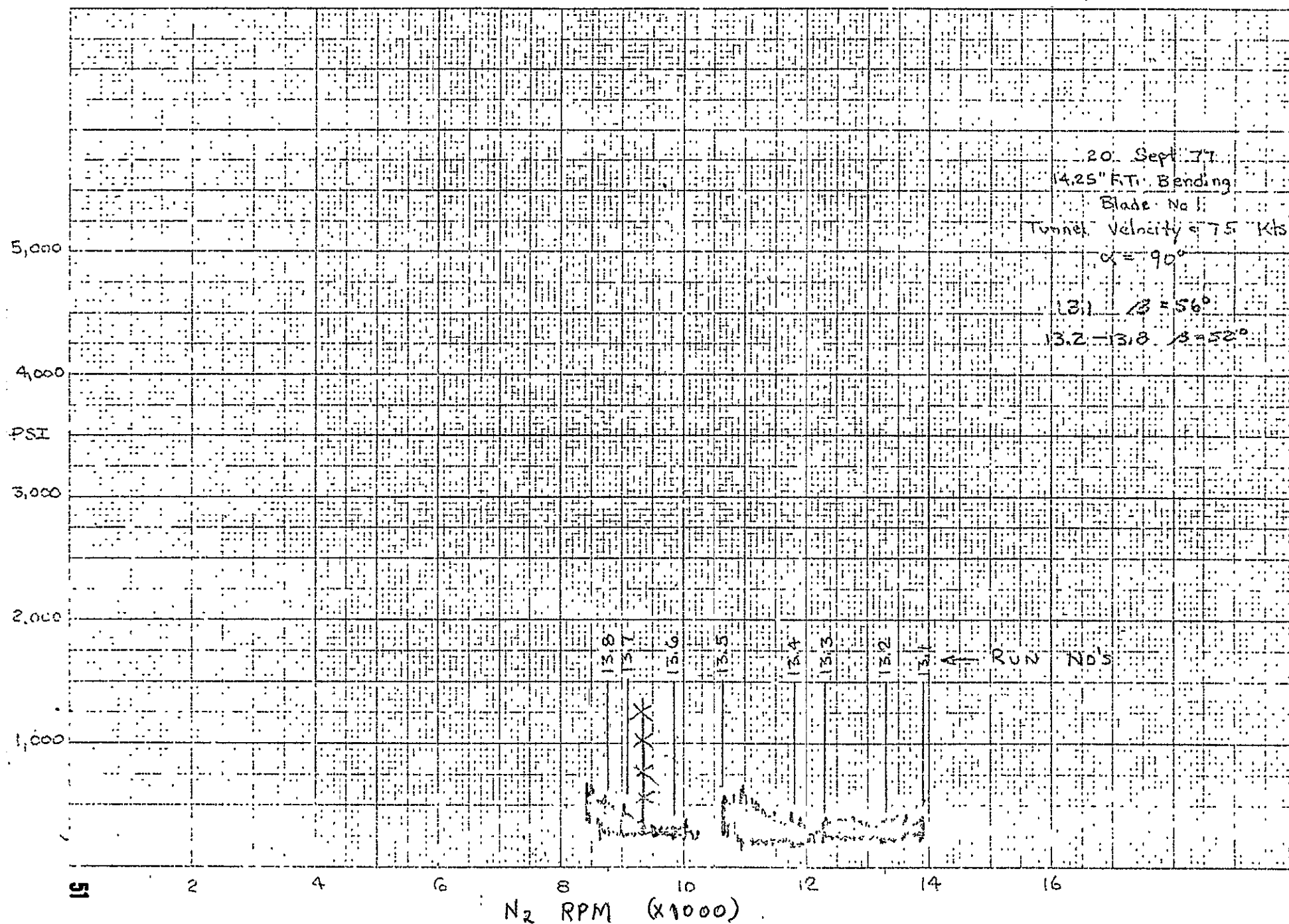
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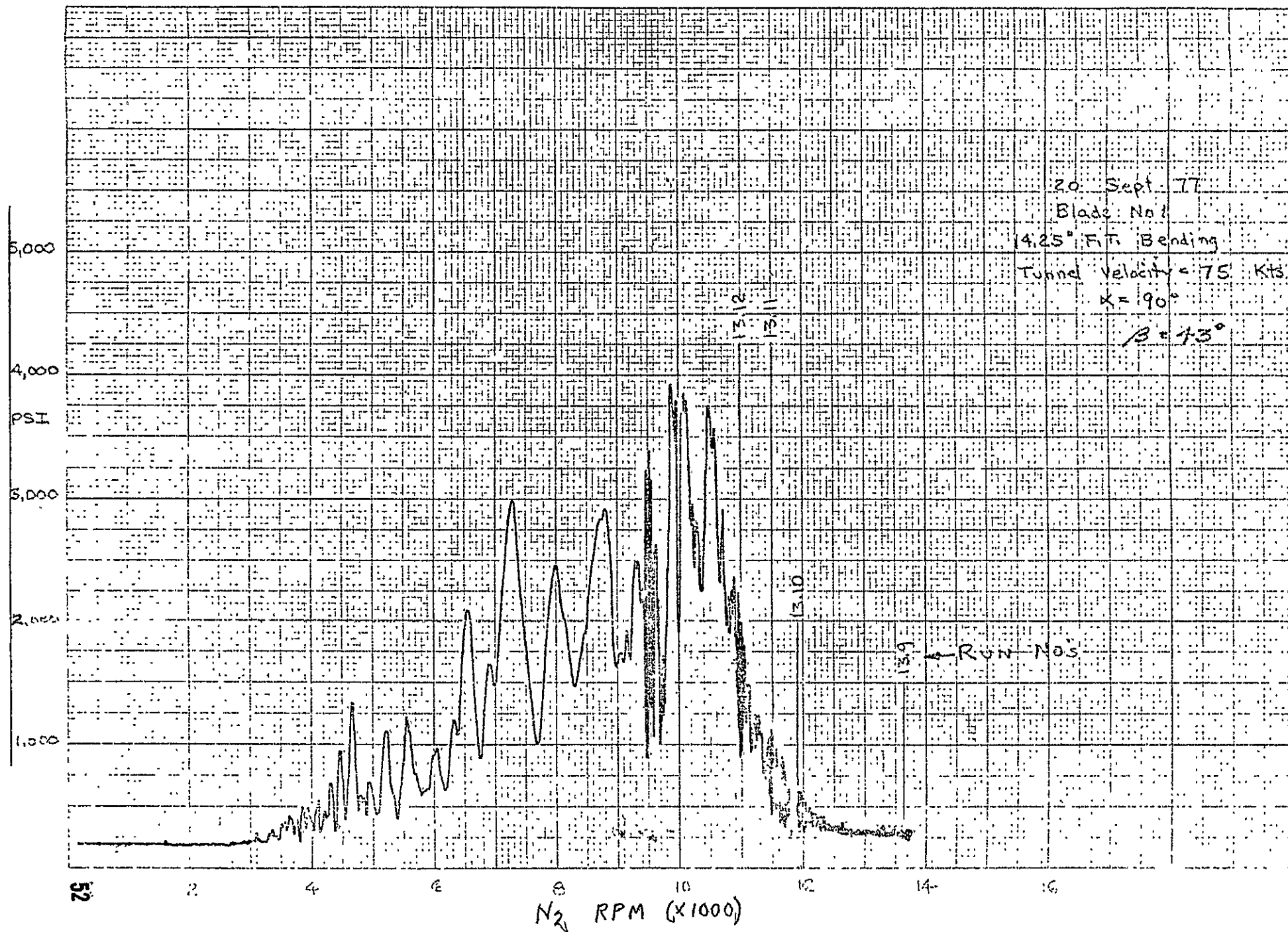


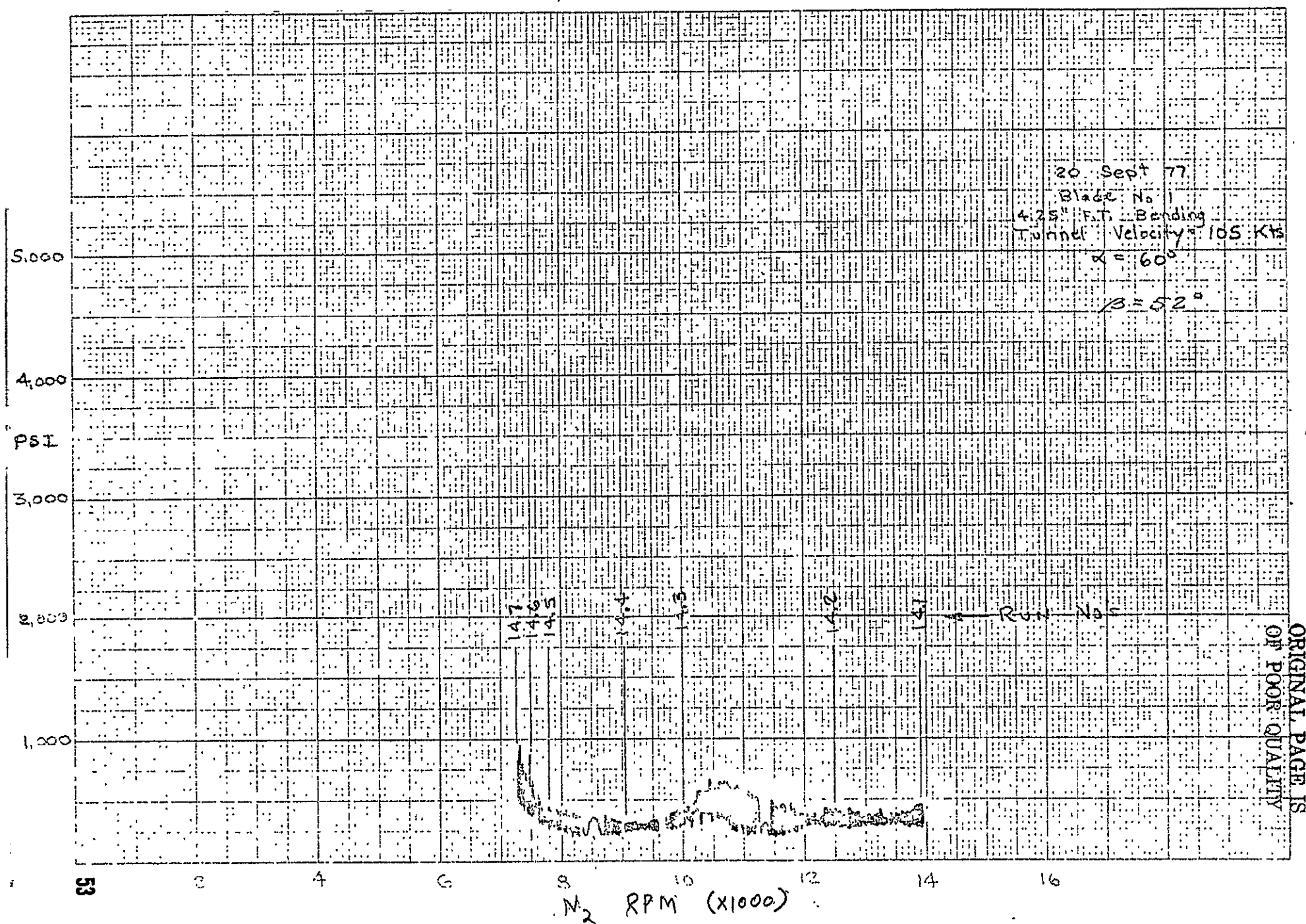
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5,000

4,000

PSI

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1,000

54

2

4

6

8

10

12

14

16

N₂ RPM (X1000)

20 Sept 77

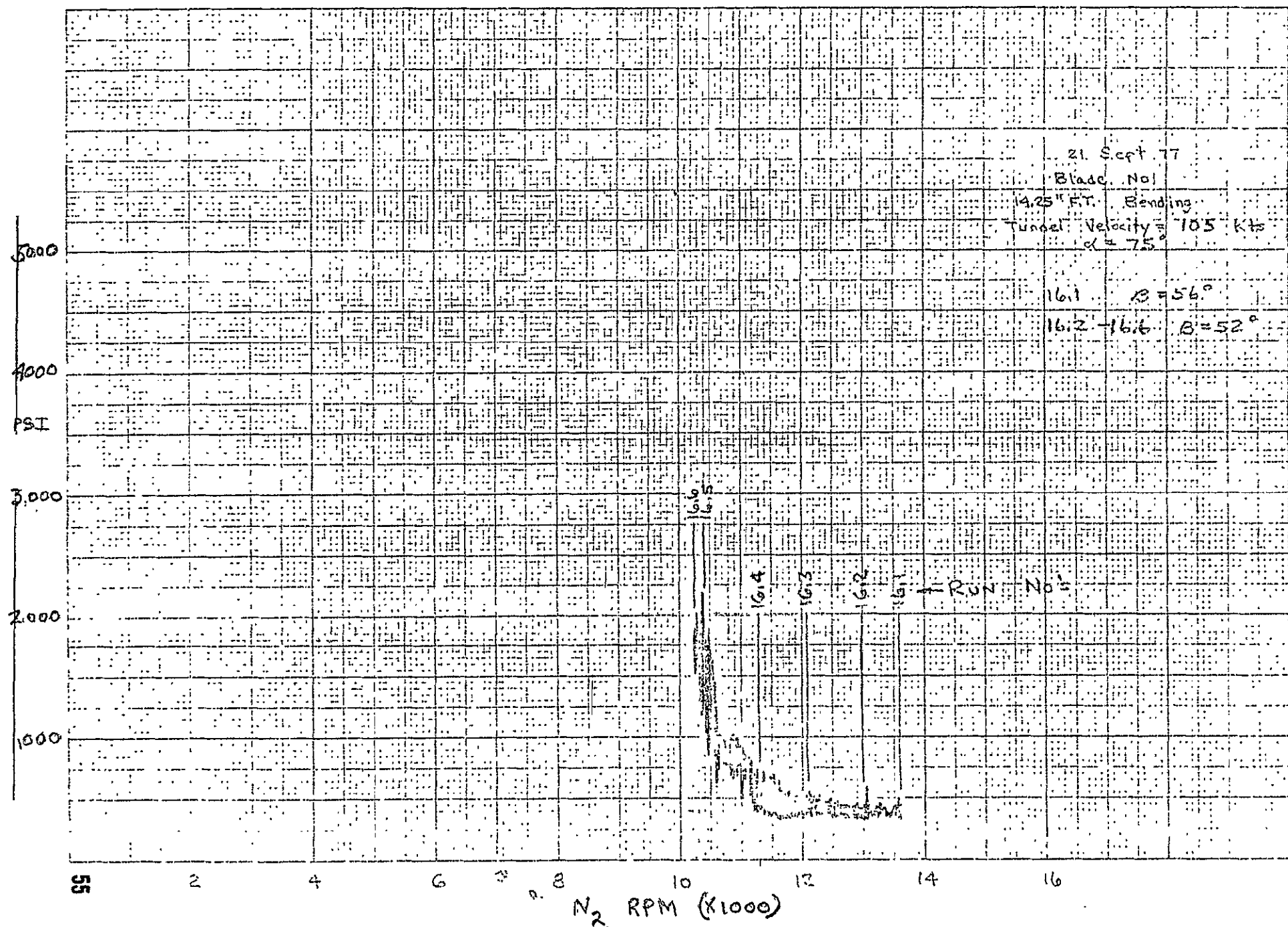
Blade No. 1

14.25" FT Bending

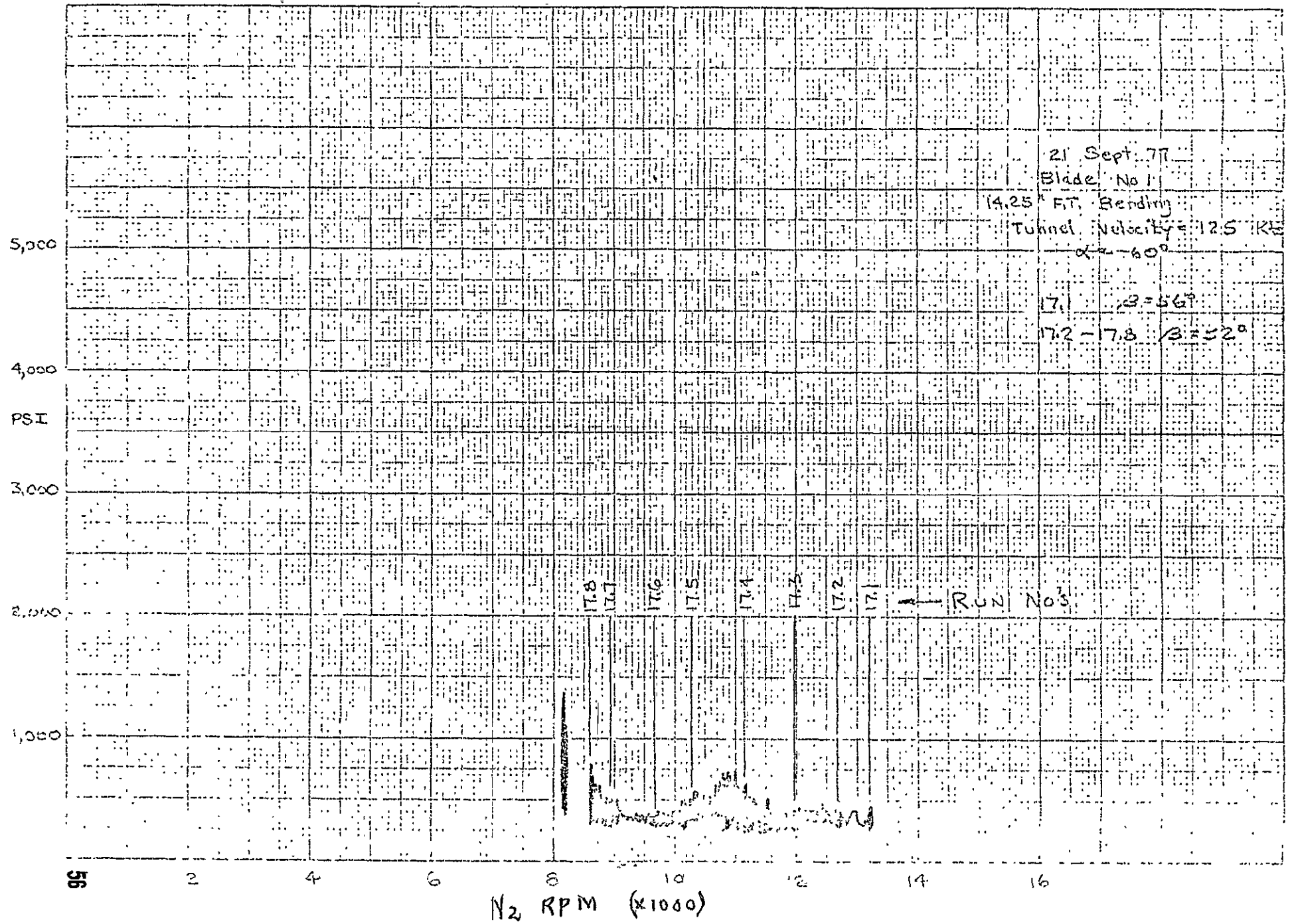
Tunnel Velocity = 105 KPH

 $\alpha = 75^\circ$ 5.1 $\beta = 5^\circ$ 152 $\beta = 52^\circ$

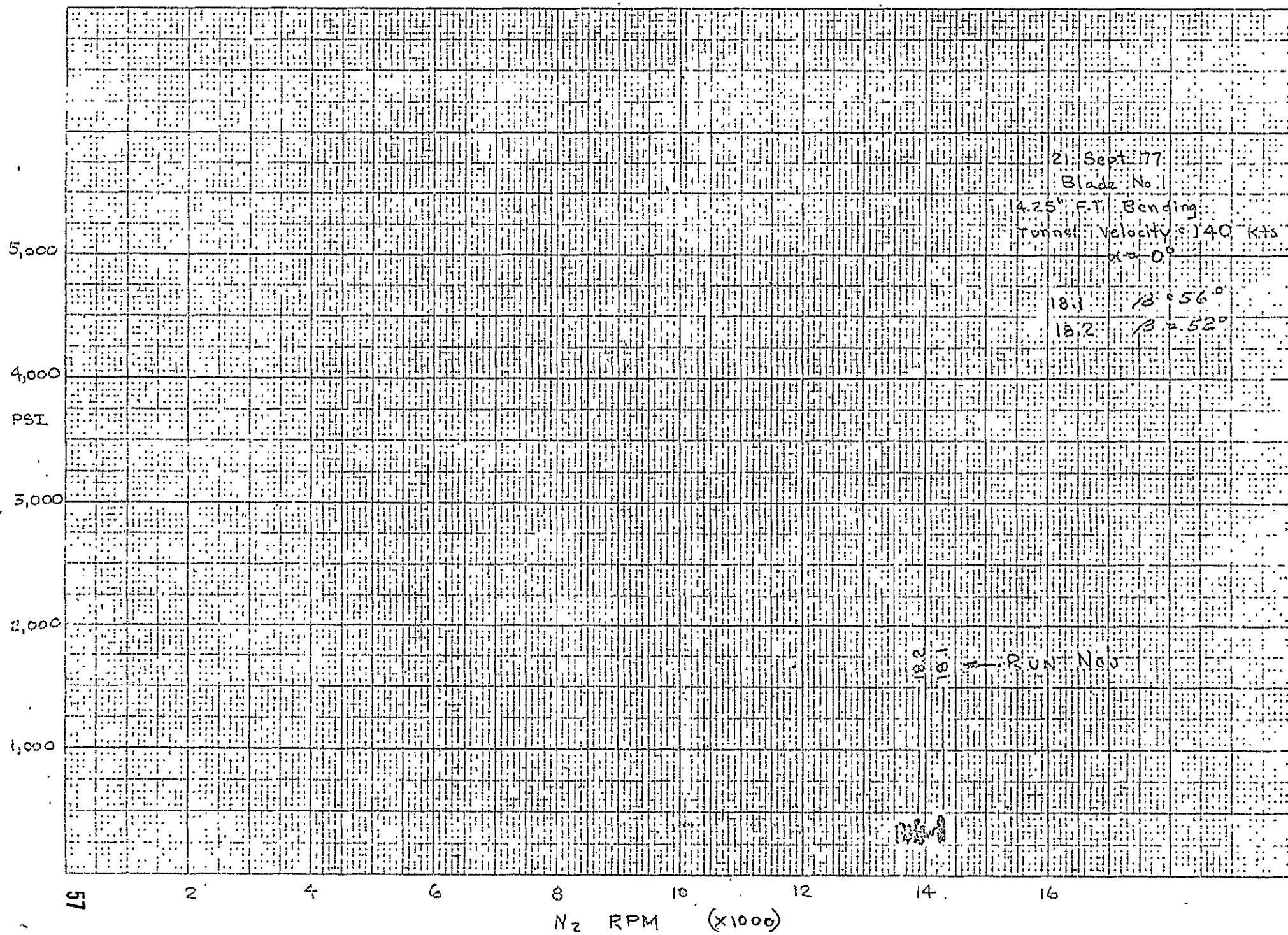
152 151 Run No's

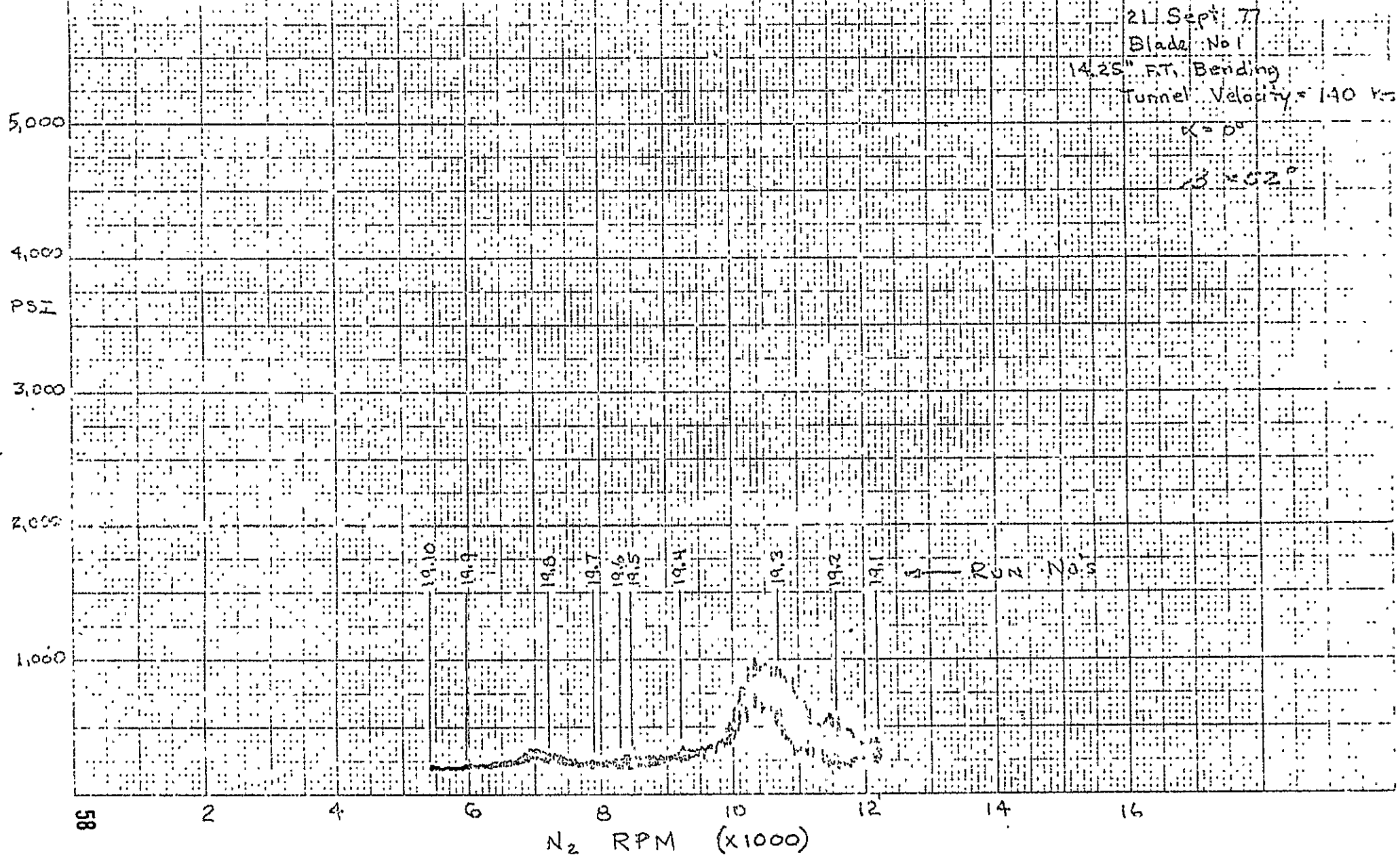


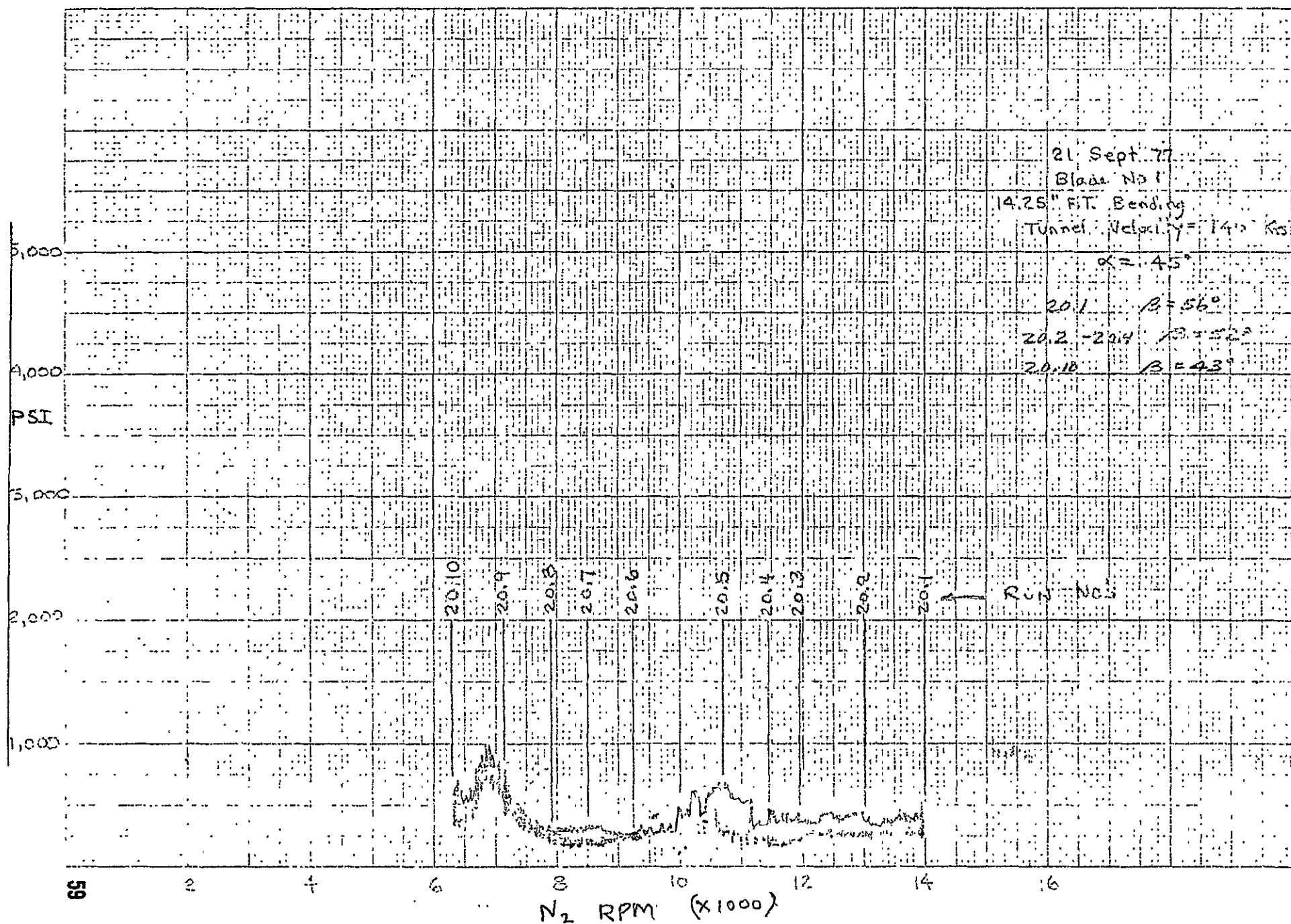
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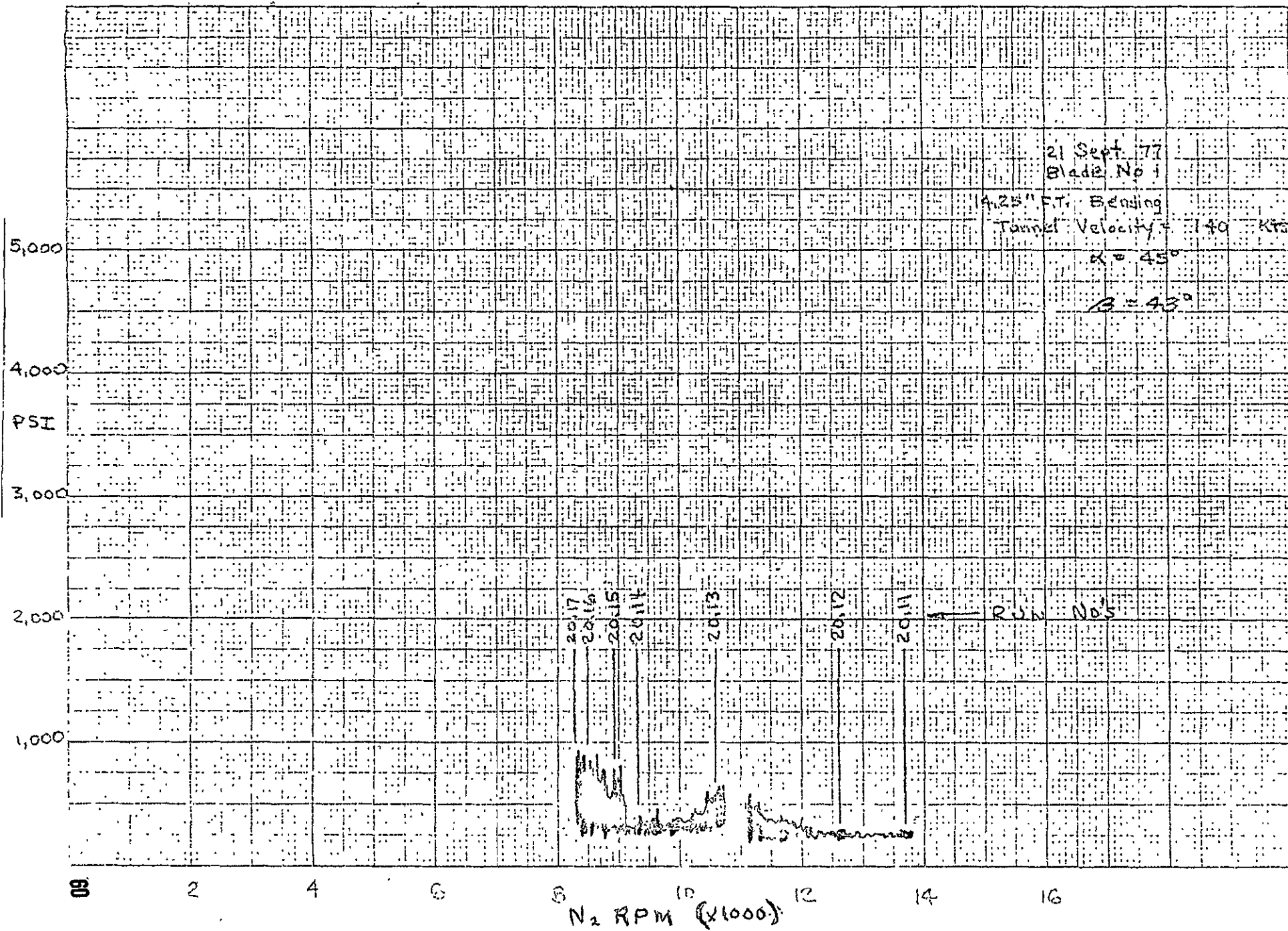


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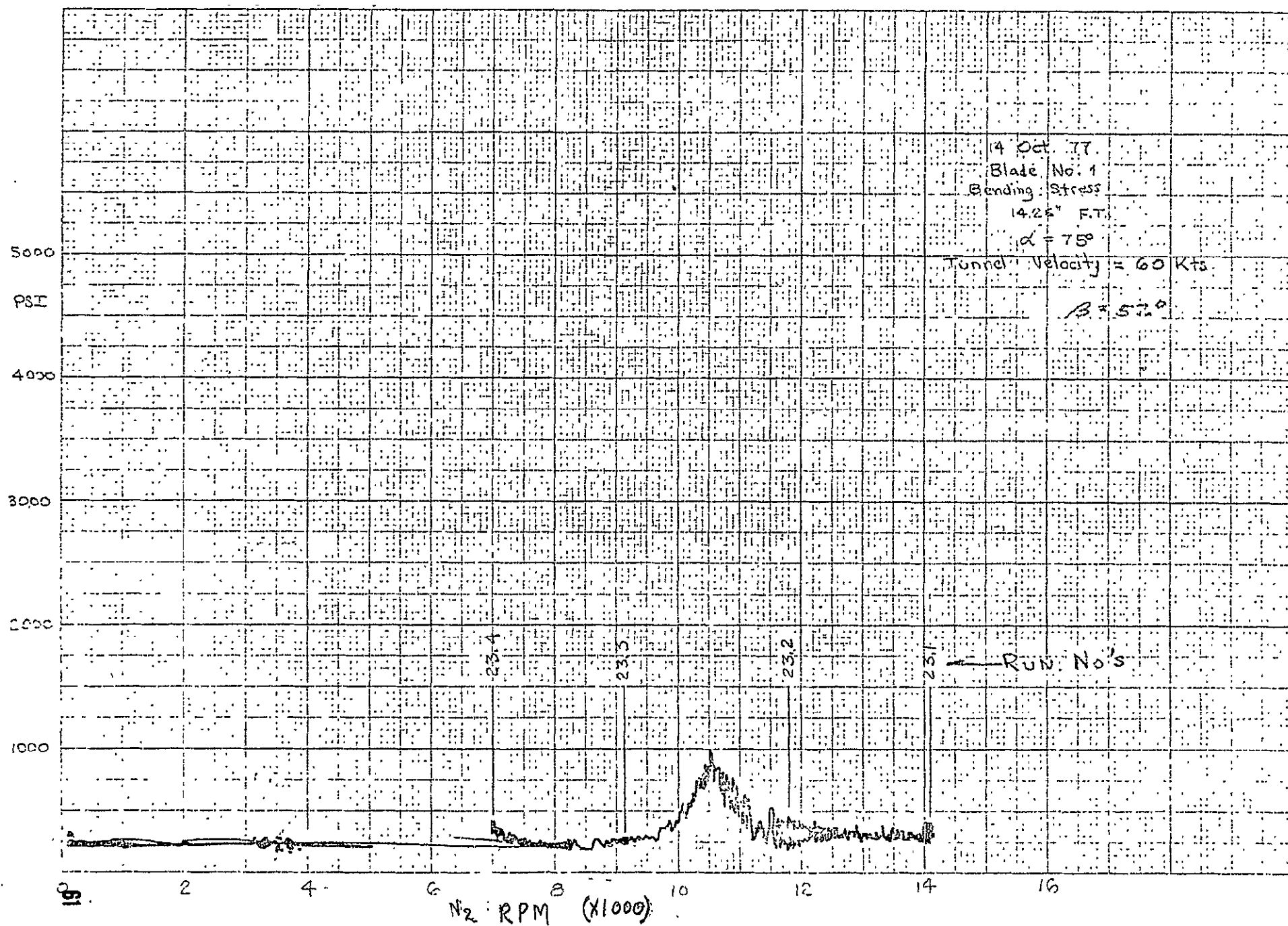


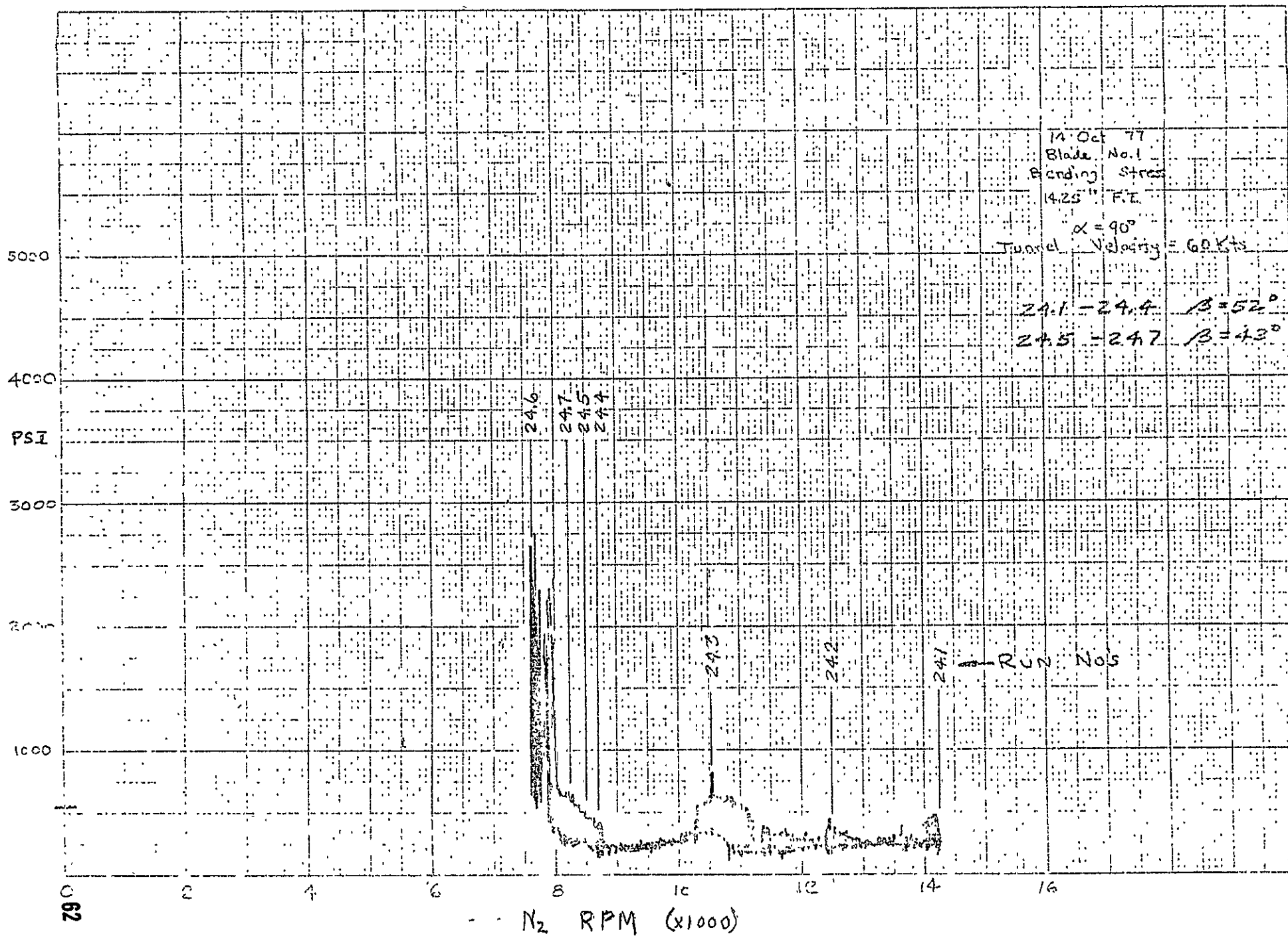


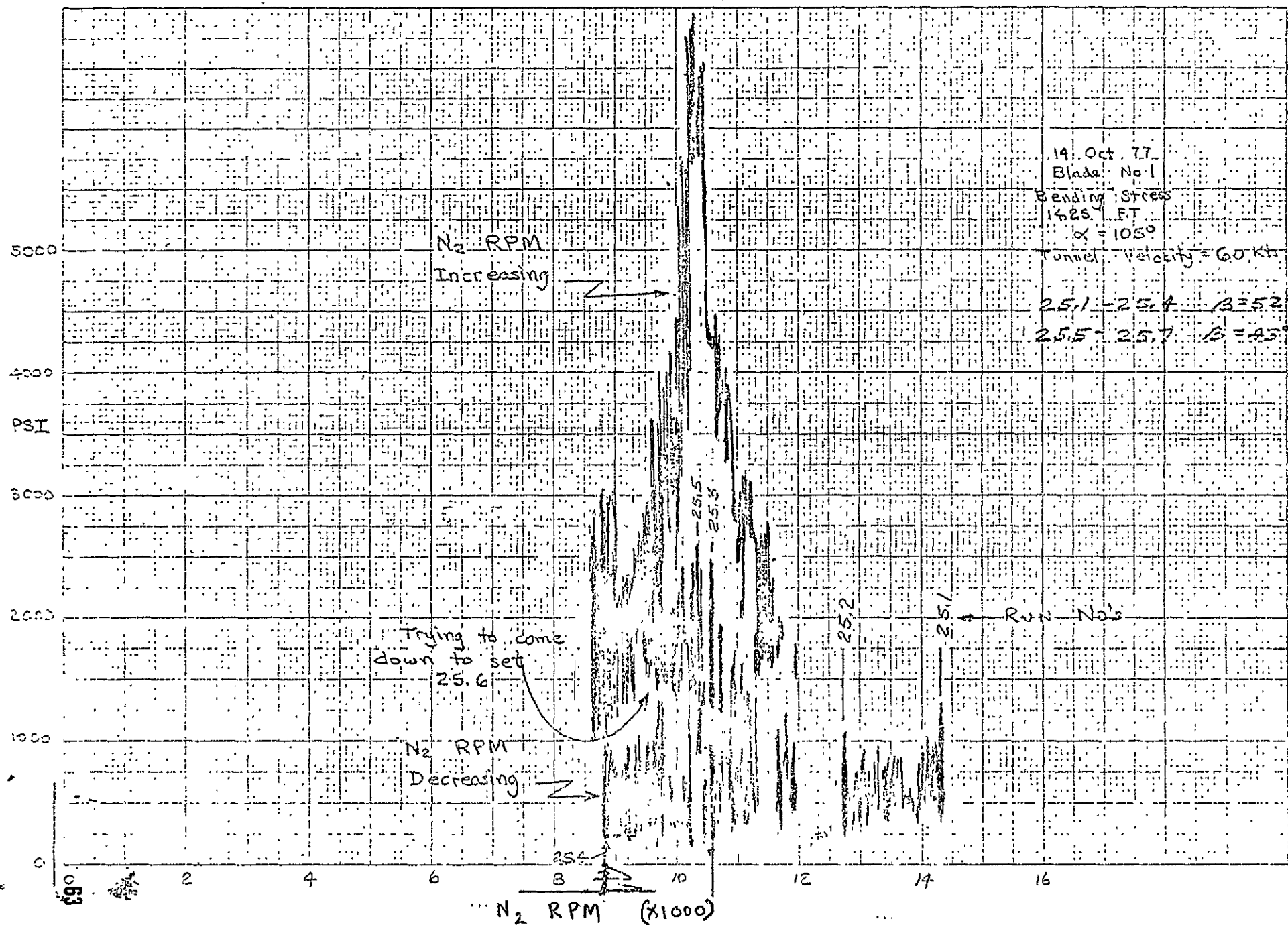
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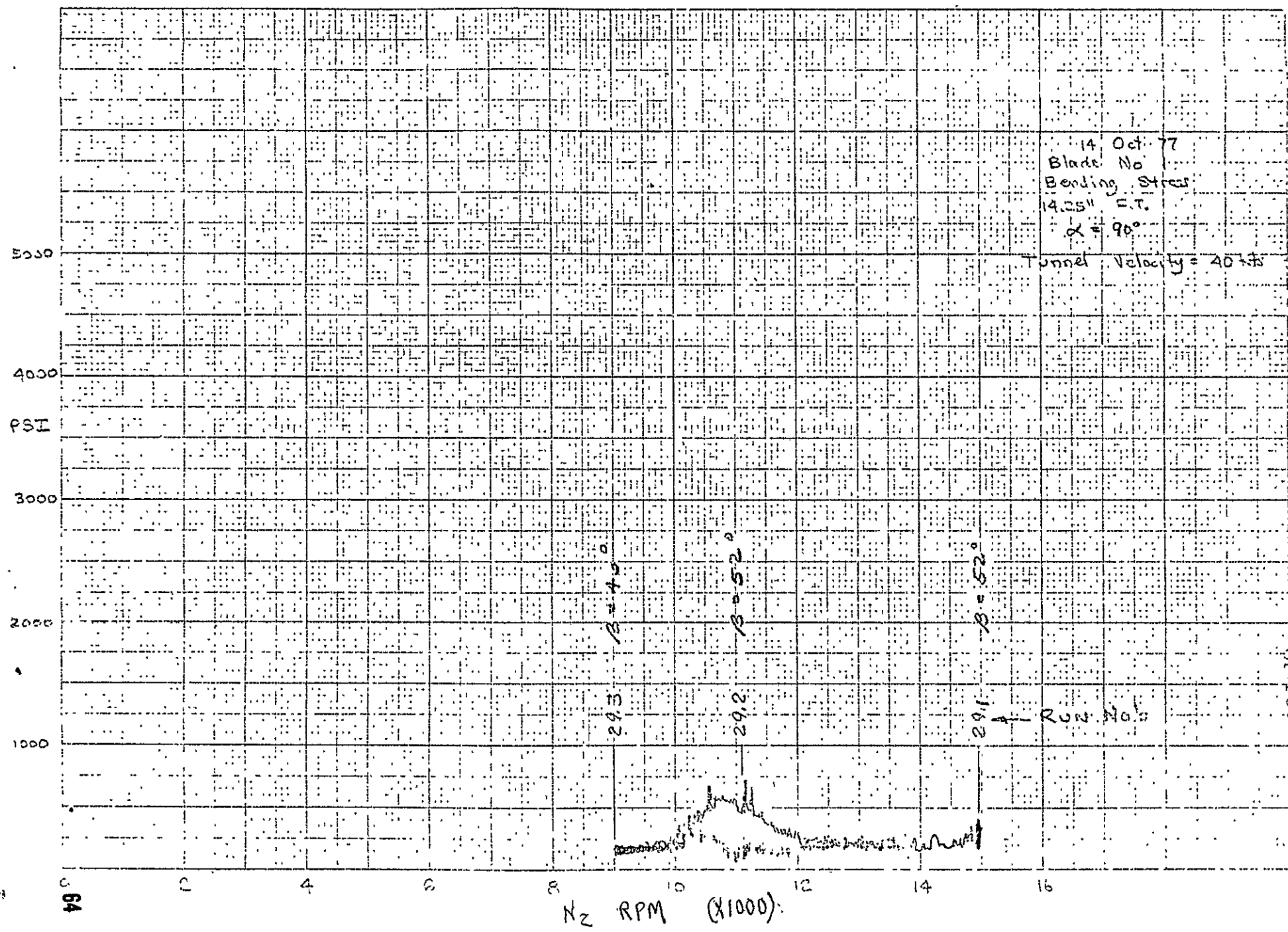
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MADE IN U.S.A.

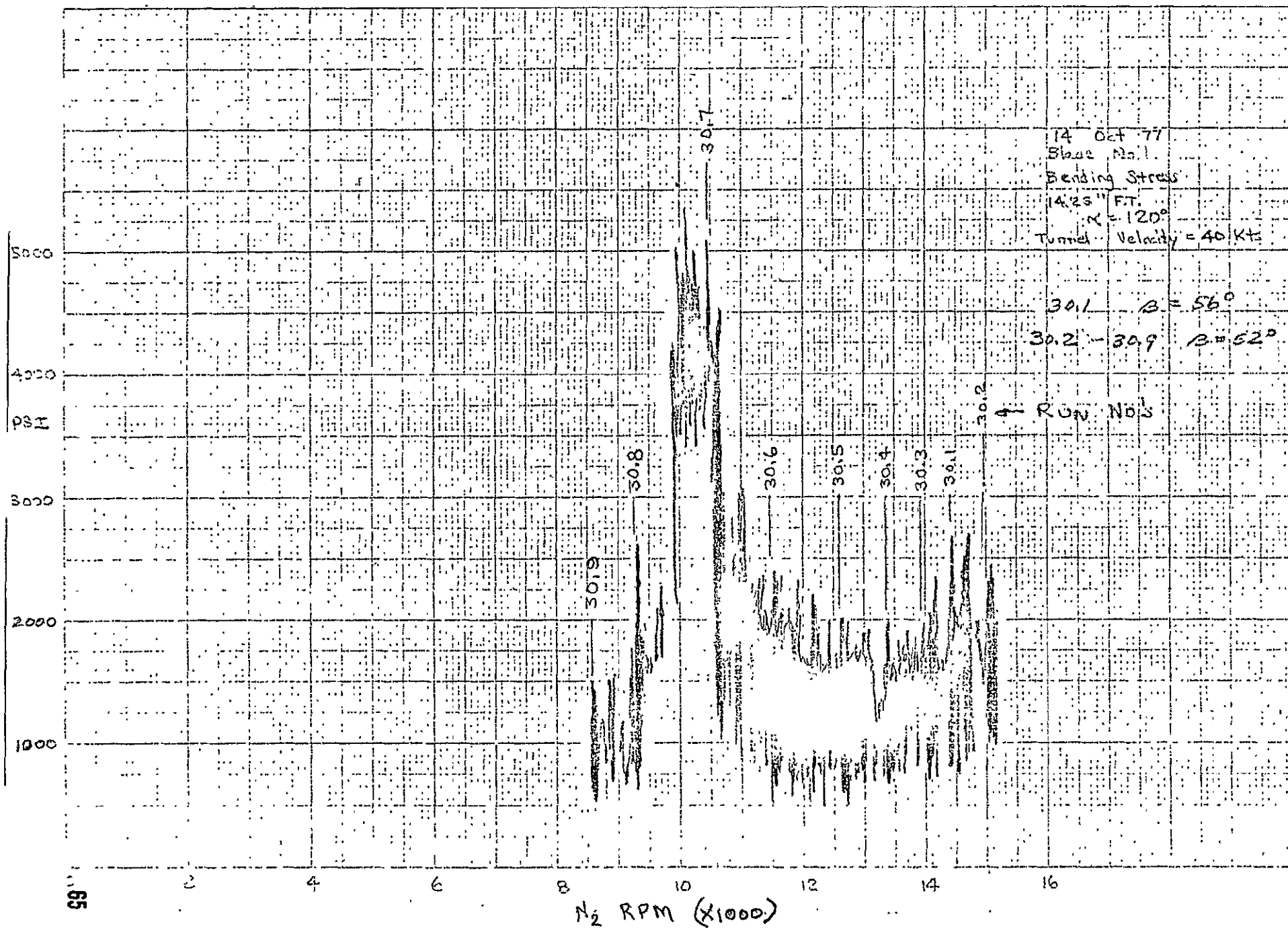


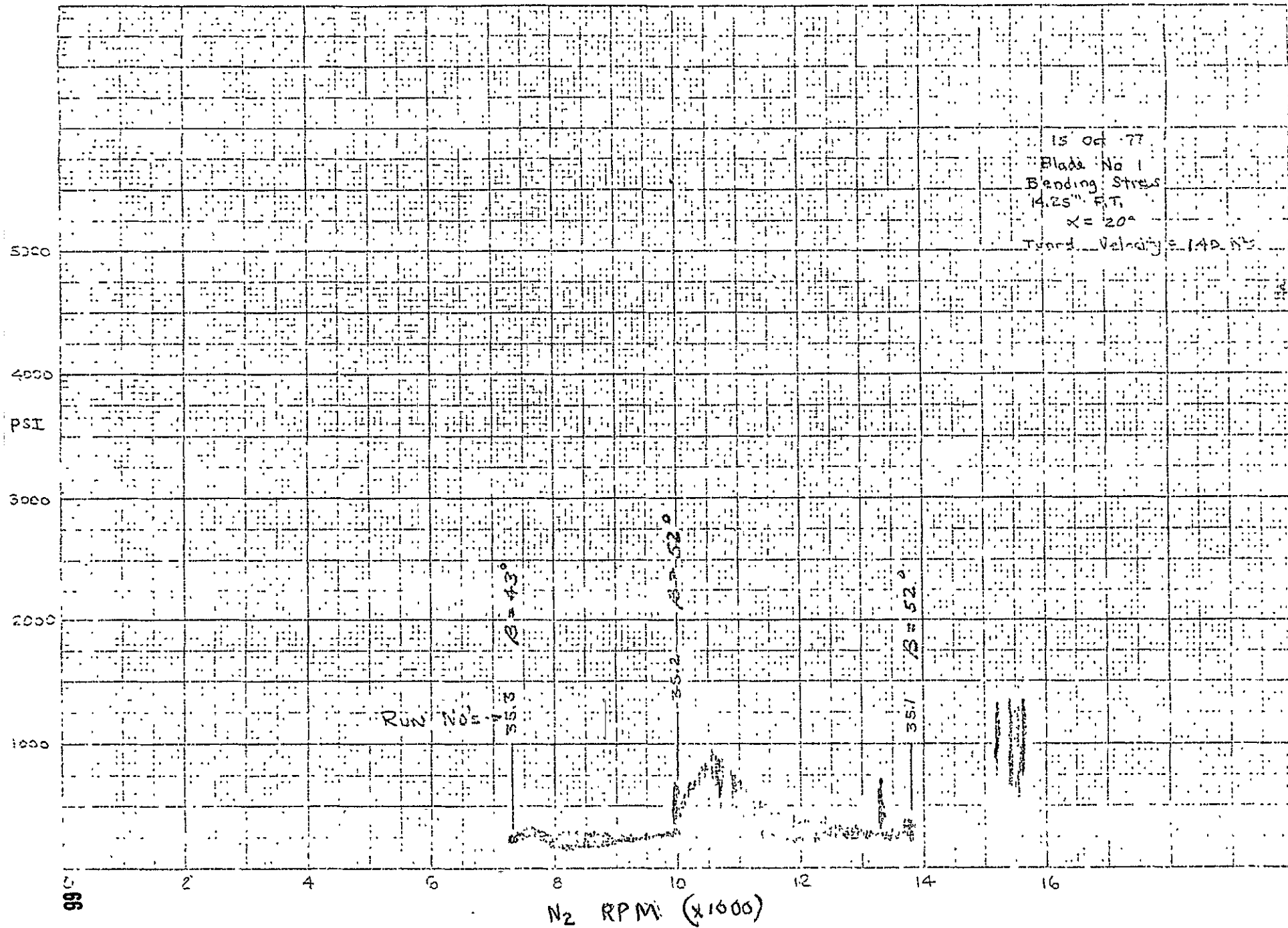




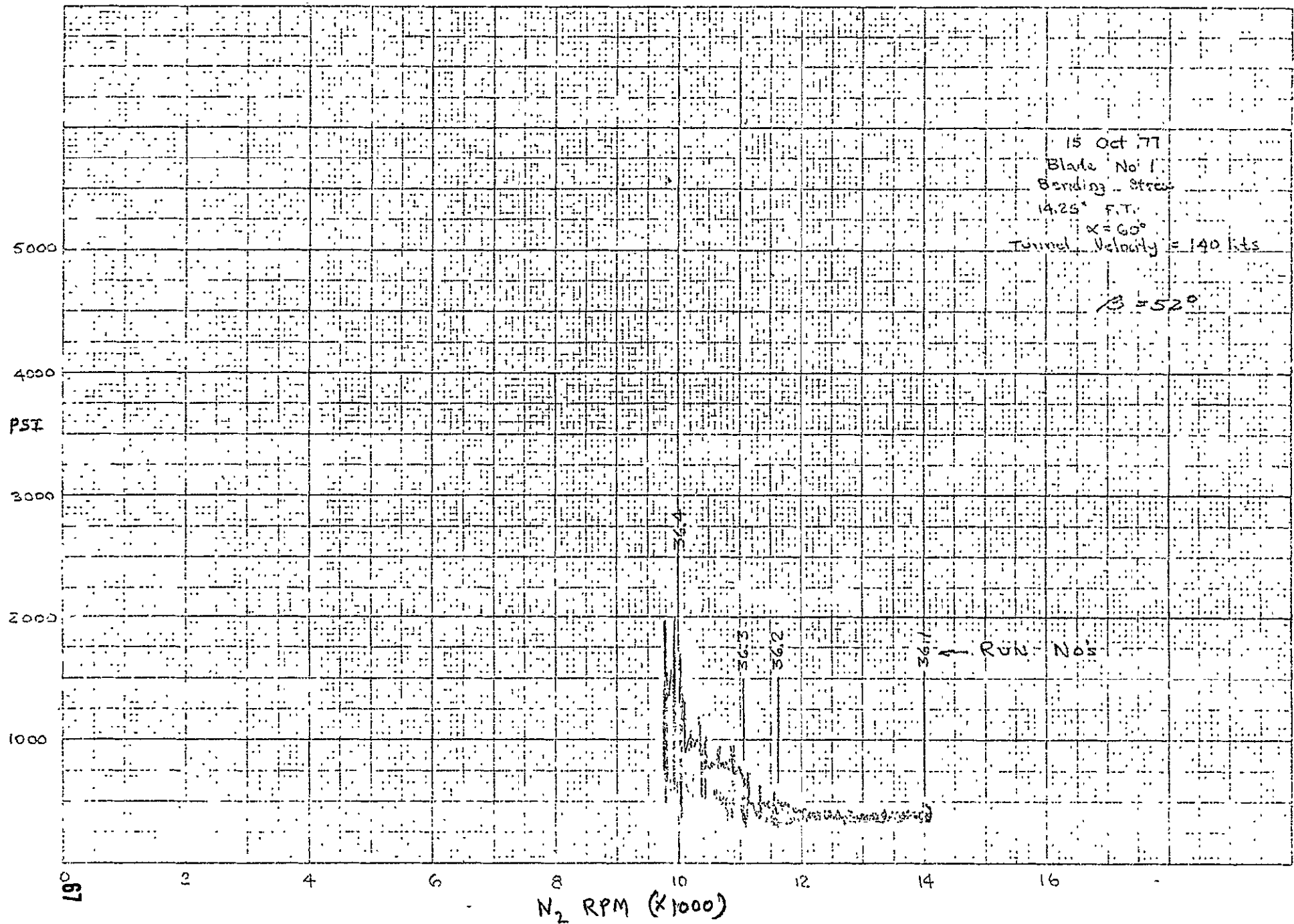


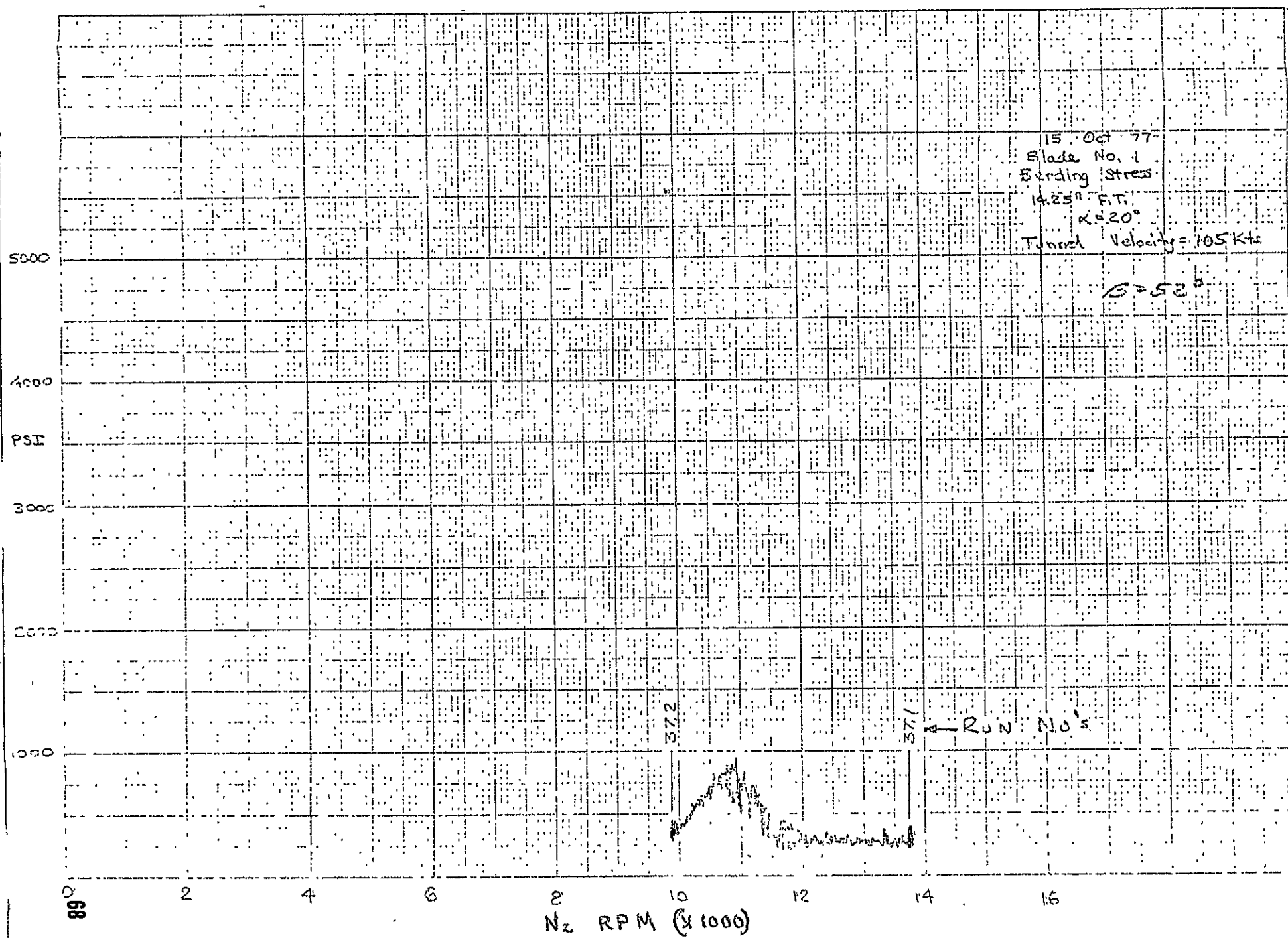
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BEING LIFT FAN TEST Q-FAN DEMO STRESS DATA TABULATION

Run # HS	TEST POINT # TORQUE	% TORQUE	RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	3.5" VEC 2	3.5" IEE 9
0	3.1	99	3250	1550	2100	2100	300	225
1	3.2	82	3075	1450	1950	1600	350	350
2	3.3	67	2725	1600	1600	1500	350	500
3	3.4	49	2300	2000	2050	1850	175	175
3	3.5	33	1950	1000	1200	1000	100	150
4	3.6	14	1750	750	950	700	75	75
5	4.1	12	1750	200	330	200	100	70
6	4.2	12	1750	1500	1900	1750	350	350
7	5.1	10	1750	300	450	300	100	75
8	5.2	10	1750	400	600	450	150	125
9	5.3	10	1750	1100	1450	1150	300	275
10	5.4	20	1625	900	1450	1250	125	150
11	5.5	20	1625	1400	2000	1800	225	175
12	5.6	29	1925	1000	1400	1100	250	200
13	5.7	29	1900	1100	1500	1200	300	200
14	6.1	9	1825	650	1000	700	120	100
15	6.2	9	1825	900	1300	1050	150	125
16	6.3	9	1825	1700	1750	1550	225	200
17	6.4	22	1700	800	1300	700	175	125
18	6.5	22	1700	950	1750	1100	225	150
19	6.6	22	1700	1600	2000	1800	300	200
20	6.7	42	2300	2100	2450	2000	300	350
21	6.8	42	2300	3200	3700	3000	375	400
22	6.9	59	2700	1300	1700	1350	350	350
23	6.10	59	2700	1500	1950	1850	450	375
24	6.11	59	2700	2000	2900	2200	500	425
25	7.1	2	1600	1450	1950	1300	150	100
26	7.2	6	1850	1600	2100	1800	275	225
27	7.3	6	1850	2800	2750	2800	300	300
28	7.4	18	1750	1200	1550	1100	200	200
29	7.5	18	1750	2400	2600	2400	350	300
30	7.6	36	2275	2850	3200	2900	400	425
31	7.7	36	2275	4200	4800	4200	475	500
32	7.8	53	2725	2300	2800	2300	575	525
33	7.9	53	2725	2700	3200	2900	700	650
34	8.1	79	3100	950	1400	1000	250	275
35	9.1	79	3075	900	1400	1200	275	200
36	9.2	66	2800	900	1200	850	225	175
37	9.3	48	2350	1200	1700	1350	150	225
38	9.4	33	2000	500	900	500	150	75
39	9.5	11	1700	250	650	300	75	70
40	10.1	77	3050	900	1350	950	225	200
41	10.2	63	2750	700	1400	800	200	200
42	10.3	41	2225	1150	1550	1150	150	150
43	10.4	21.5	1675	400	700	575	100	60
44	10.5	8.5	1650	850	1350	800	100	60

REF # 013451

BOEING LIFT FAN TEST Q-FAN DEMO STRESS DATA TABULATION

Run#	TEST POINT#	% TORQUE	RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	3.5" YEE 2	3.5" YEE 9
45	11.1	76	3075	1000	1400	1100	300	225
46	11.2	60	2725	800	1200	800	250	225
47	11.3	37	2125	800	1350	800	150	175
48	11.4	19	1600	1800	2150	1300	200	200
49	11.5	15	2000	1200	1500	1100	275	225
50	11.6	13	1925	1700	2100	1500	350	300
51	12.1	75	3050	950	1450	950	250	200
52	12.2	62	2775	850	1350	900	200	200
53	12.3	43	2325	1700	1950	1550	150	175
54	12.4	18	1600	650	950	450	75	85
55	12.5	8	1650	450	900	350	100	75
56	13.1	93	2950	600	700	600	350	250
57	13.2	73	2800	400	600	400	250	300
58	13.3	62	2600	350	500	400	550	350
59	13.4	57	2500	350	500	450	500	400
60	13.5	45	2250	500	700	450	250	225
61	13.6	38	2050	450	700	500	250	200
62	13.7	30	1850	550	700	500	300	200
63	13.8	28	1825	850	900	800	400	225
64	13.9	36	2900	300	450	350	250	250
65	13.10	25	2500	550	800	600	450	450
66	13.11	23	2425	900	1050	900	450	475
67	13.12	21	2300	1950	2400	2000	475	475
68								
69	14.1	75	2950	450	600	500	250	250
70	14.2	59	2600	400	500	350	300	250
71	14.3	33	2000	350	550	300	200	150
72	14.4	27	1850	250	400	250	200	80
73	14.5	18	1600	450	550	400	225	100
74	14.6	16	1550	700	800	650	225	175
75	14.7	15	1500	1000	1350	950	250	175
76	15.1	88	2900	600	800	700	300	225
77	15.2	68	1925	550	750	600	300	275
78	16.1	88	2900	650	850	800	300	225
79	16.2	68	2775	500	800	550	300	275
80	16.3	58	1550	500	700	450	550	500
81	16.4	50	2400	650	950	650	425	450
82	16.5	41	2200	1850	2000	1600	400	350
83	16.6	39	2175	2500	2700	2400	450	425
84	17.1	82	2800	475	600	580	300	300
85	17.2	60	2700	500	750	450	275	275
86	17.3	52	2550	400	550	450	550	475
87	17.4	44	2350	600	600	450	350	325
88	17.5	35	2175	650	1000	700	225	175
89	17.6	30	2025	500	1150	500	250	225
90	17.7	25	1900	600	850	650	300	275
91	17.8	21	1800	775	1400	1350	475	475

BOEING LIFT FAN TEST Q-FAN DEMO STRESS DATA TABULATION

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Run #	TEST POINT #	% TORQUE	RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	3.5" VEE 2	3.5" VEE 9
92	18.1	91	3050	650	800	600	250	325
93	18.2	73	2975	450	650	500	200	225
94	19.1	57	2600	450	575	475	250	300
95	19.2	50	2450	475	600	550	275	325
96	19.3	42	2250	800	975	700	175	200
97	19.4	30	1950	300	450	300	150	100
98	19.5	23	1750	200	350	250	175	90
99	19.6	23	1750	200	400	250	175	100
100	19.7	18	1650	200	350	200	100	100
101	19.8	14	1500	250	400	225	100	75
102	19.9	6	1250	150	300	175	100	75
103	19.10	4	1175	125	325	200	100	75
104	20.1	89	3000	550	850	600	275	275
105	.2	64	2800	375	700	450	250	225
106	.3	53	2575	300	475	400	300	300
107	.4	48	2450	375	550	480	300	325
108	.5	38	2250	650	800	600	225	225
109	.6	26	1950	300	450	300	200	175
110	.7	20	1800	250	450	250	175	125
111	.8	16	1650	275	550	400	175	100
112	.9	10	1500	700	800	800	150	150
113	.10	6	1300	800	950	750	225	175
114	.11	26	2950	250	450	300	250	225
115	.12	20	2700	250	550	325	250	175
116	.13	12	2300	600	850	700	200	125
117	.14	6.5	2000	550	750	600	275	150
118	.15	5	1900	650	900	700	325	175
119	.16	4	1800	1000	1500	1300	400	275
120	20.17	3	1750	1300	1575	1700	450	325
121	23.1	79	3000	450	550	450	250	175
122	.2	57	2550	400	450	450	400	275
123	.3	32	1950	300	450	225	150	80
124	.4	16	?	350	450	175	150	100
125	23.5	10		300	700	350	150	100
126	24.1	80	3050	500	650	500	300	325
127	.2	63	2575	450	500	375	250	300
128	.3	45	2250	700	800	500	200	175
129	.4	28	1875	300	400	200	125	150
130	.5	14	1850	500	700	500	250	275
131	.6	11	1625	3000	3800	3900	750	1100
132	24.7	12	1750	800	950	900	350	375
133	25.1	80	3050	1900	2900	2600	950	1050
134	.2	67	2750	2200	2400	2000	850	800
134	.3	46	2300	2800	3200	2900	625	550
135	.4	30	1900	1150	1600	1300	500	475
136	.5	20	2000	1250	1700	1700	500	650
137	.6	15	1850	4400	5100	4400	700	700
138	25.7	35	2875	1400	1300	1300	700	750

BOEING LIFT FAN TEST Q-FAN DEMO STRESS DATA TABULATION

RUN #	TFST POINT #	% TORQUE	RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	3.5" VEE 2	3.5" VEE 7	
REFL 013/911	139	26.1	75	3000	500	700	450	350	325
	140	.2	60	2700	400	600	350	250	300
	141	.3	38	2175	600	700	475	325	175
	142	.4	22	1725	250	450	200	150	100
	143	.5	10	1800	350	500	300	250	200
	144	.6	9	1725	500	600	350	225	150
	145	.7	8	1650	900	1000	775	350	225
	146	26.8	4	1375	2800	2850	2800	450	550
	147	27.1	73	3000	575	700	550	300	350
	148	.2	58	2675	450	600	400	350	350
	149	.3	37	2150	550	850	500	200	175
	150	.4	26	1850	550	750	550	300	225
	151	.5	20	1650	5000	5800	6000	850	750
	152	.6	16	2000	5800	5600	5900	850	1000
	153	.7	32	2000	450	650	475	300	175
	154	.8	16	2000	5800	6200	5700	950	850
	155	27.9	20	2350	1450	1900	1400	425	350
	156	28.1	77	3050	600	650	550	450	350
	157	.2	60	2700	500	700	475	400	300
	158	.3	50	2450	650	950	650	475	500
	159	.4	46	2350	950	1350	750	475	425
	160	28.5	40	2225	2800	3350	2600	525	425
	161	29.1	85	3200	600	900	800	450	400
	162	.2	50	2400	600	800	600	325	350
	163	29.3	16	1950	200	380	250	175	120
	164	30.1	97	3150	5000	4600	4900	1350	1400
	165	.2	87	3250	11000	4900	4800	1450	1200
	166	.3	79	3050	3300	4800	3850	1350	1425
	167	.4	73	2900	3200	3950	4400	1275	1250
	168	.5	66	2750	3200	3900	3400	1150	1000
	169	.6	55	2500	3100	4300	3800	1100	1050
	170	.7	46	2300	5500	5700	5000	900	800
	171	.8	34	2000	3400	3700	3500	800	750
	172	30.9	29	1850	2300	2400	2650	650	600

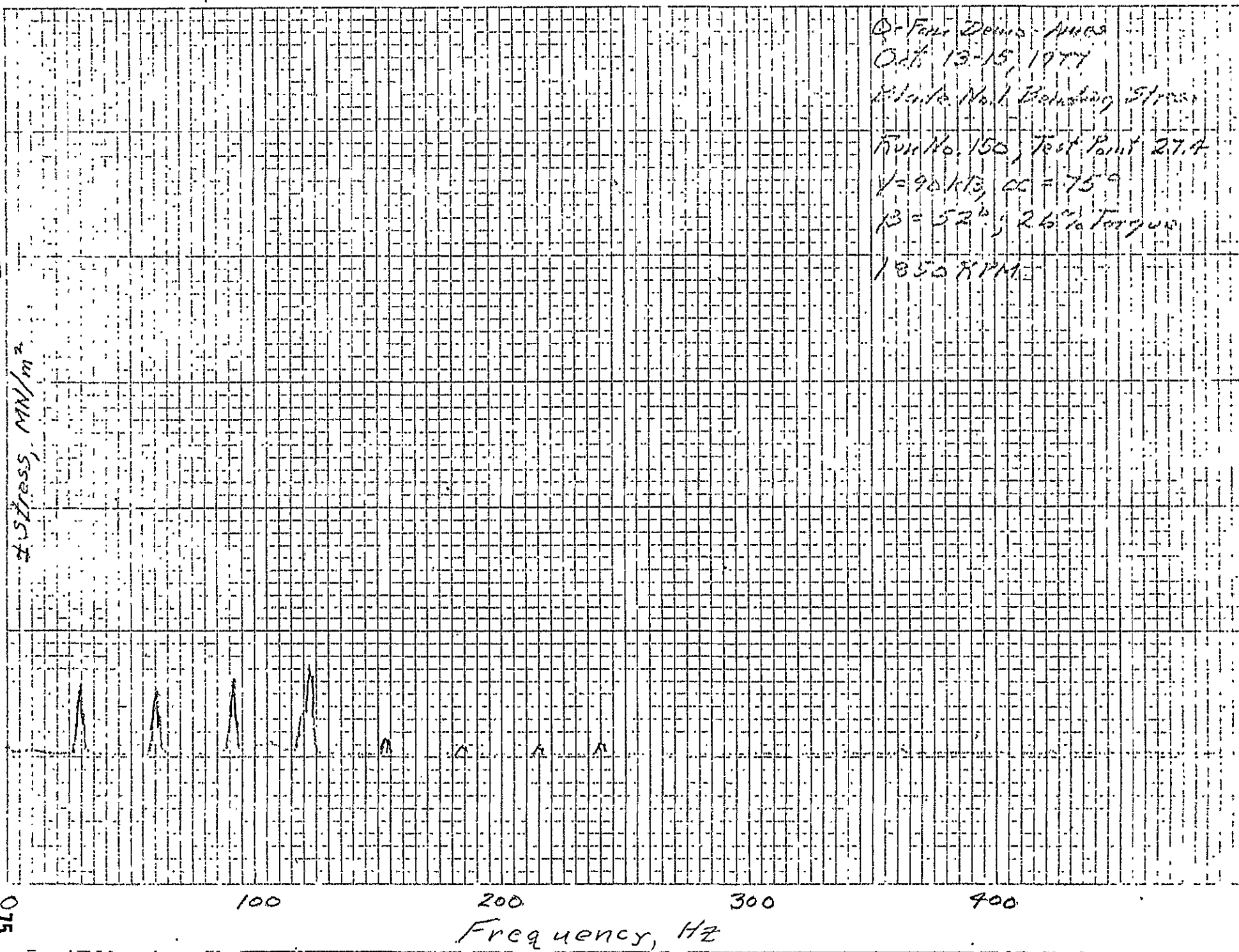
ORIGINAL PAGE IS
OF POOR QUALITYBOEING LIFT FAN TEST
Q-FAN DEMO
STRESS DATA TABULATION

RUN#	TEST POINT#	% TORQUE	RPM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	35" VEE 2	35" VEE 9
REEH Q134H 173	31.1	24	1750	300	450	300	150	150
174	31.2	"	1750	500	700	500	225	200
175	31.3	"	1750	1300	1500	1400	350	325
176	31.4	"	1750	6000	5400	6400	800	850
177	31.5	"	1750	5800	5800	6000	850	800
178	31.6	"	1750	700	950	750	325	375
179	31.7	"	1750	700	975	650	275	350
180	32.1	11	1950	200	400	225	150	100
181	.2	11	1950	250	475	350	200	150
182	.3	11	1950	475	650	500	275	225
183	.4	11	1950	900	1500	1000	550	350
184	.5	26	1900	300	450	100	200	200
185	.6	26	1900	350	550	450	250	225
186	.7	26	1900	500	750	550	300	225
187	.8	26	1900	1350	1450	1350	525	350
188	.9	41	2350	600	700	500	250	275
189	.10	42	2300	1000	1400	1000	375	400
190	.11	43	2350	1400	1800	1400	475	500
191	.12	43	2300	2200	2600	2350	600	650
192	.13	66	2900	600	850	500	250	275
193	.14	66	2900	800	950	800	475	400
194	.15	66	2900	900	1200	975	525	500
195	.16	66	2875	1100	1450	1150	625	675
196	.17	66	2875	1250	1500	1400	700	775
197	.18	89	3050	650	875	650	350	300
198	.19	89	3050	950	1100	1000	525	475
199	.20	89	3050	1350	1450	1450	600	725
200	32.21	89	3050	1450	1750	1850	725	850
201	33.1	81	3000	1450	1500	1475	675	725
202	33.2	84	3000	1750	1900	1850	775	875
203	34.1	3	1725	350	550	450	150	125
204	.2	2	1725	900	1150	1050	350	300
205	.3	26	2000	400	550	350	225	200
206	.4	26	2025	800	1000	700	300	225
207	.5	26	2025	1200	1600	1025	450	400
208	.6	50	2600	450	500	350	375	350
209	.7	50	2600	650	850	650	400	400
210	.8	50	2600	700	900	800	450	450
211	.9	50	2600	1150	1300	1100	575	550
212	.10	77	2850	475	600	550	250	325
213	.11	76	2850	1000	1350	1150	575	775
214	.12	76	2850	1675	2000	1700	850	1125
215	35.1	70	2950	400	600	450	200	250
216	.2	34	2150	500	850	400	150	175
217	.3	5	1550	200	375	200	100	100

BOEING LIFT FAN TEST Q-FAN DEMO STRESS DATA TABULATION

RUN#	TEST POINT #	% TORQUE	RTM	14.25" BEND 1	14.25" BEND 6	14.25" BEND 7	35" VEE 2	35" VEE 9	
REFL 13494 ↓	218	36.1	70	3025	600	950	600	400	375
	219	.2	46	2500	500	650	500	575	600
	220	3	40	2400	650	850	700	450	450
	221	.4	31	2150	1900	2500	1450	475	475
	222	36.5	30	2100	2500	2975	1975	650	575
13495	223	37.1	71	2950	450	500	500	225	275
	224	37.2	40	2250	750	1100	750	200	225
	225	37.3	4.5	1400	200	300	250	125	100
↓	226	38.1	81	3150	500	600	650	300	225
	227	38.2	45	2325	900	900	950	225	325
	228	38.3	10	1700	300	300	350	150	150
END OF BOEING TEST									

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Q-Fall Demo - Annex
Oct. 13-15, 1977
Blade No. 1 Bending Stress
Run No. 151, Test Point 27.5
 $V = 90 \text{ KHz}$, $\alpha = 75^\circ$
 $\beta = 52^\circ$, 20% Torque
1650 R.P.M.

8

6

4

2

0

$\pm$ Stress, MN/m^2

076

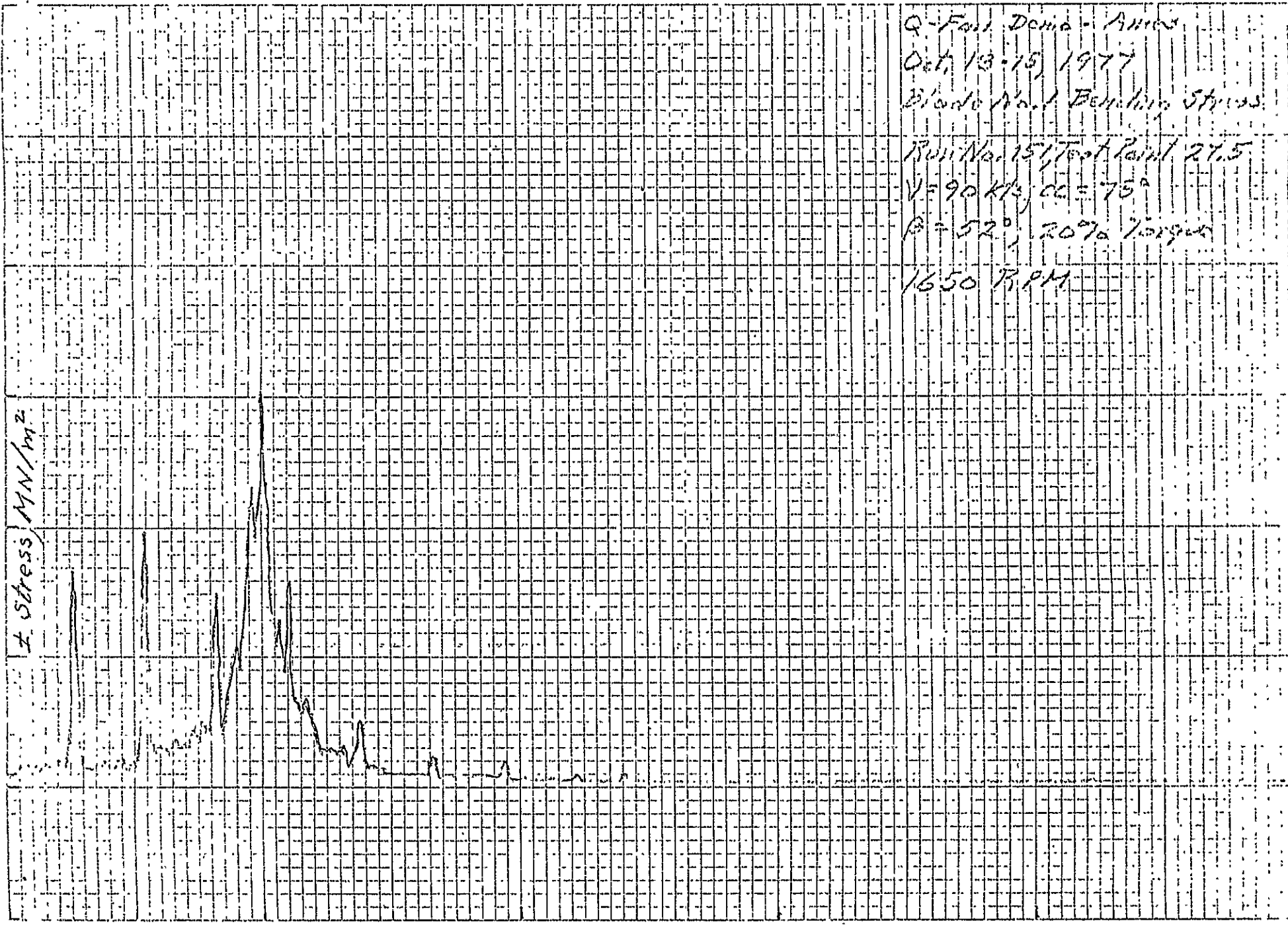
100

200

300

400

Frequency, Hz



80

6

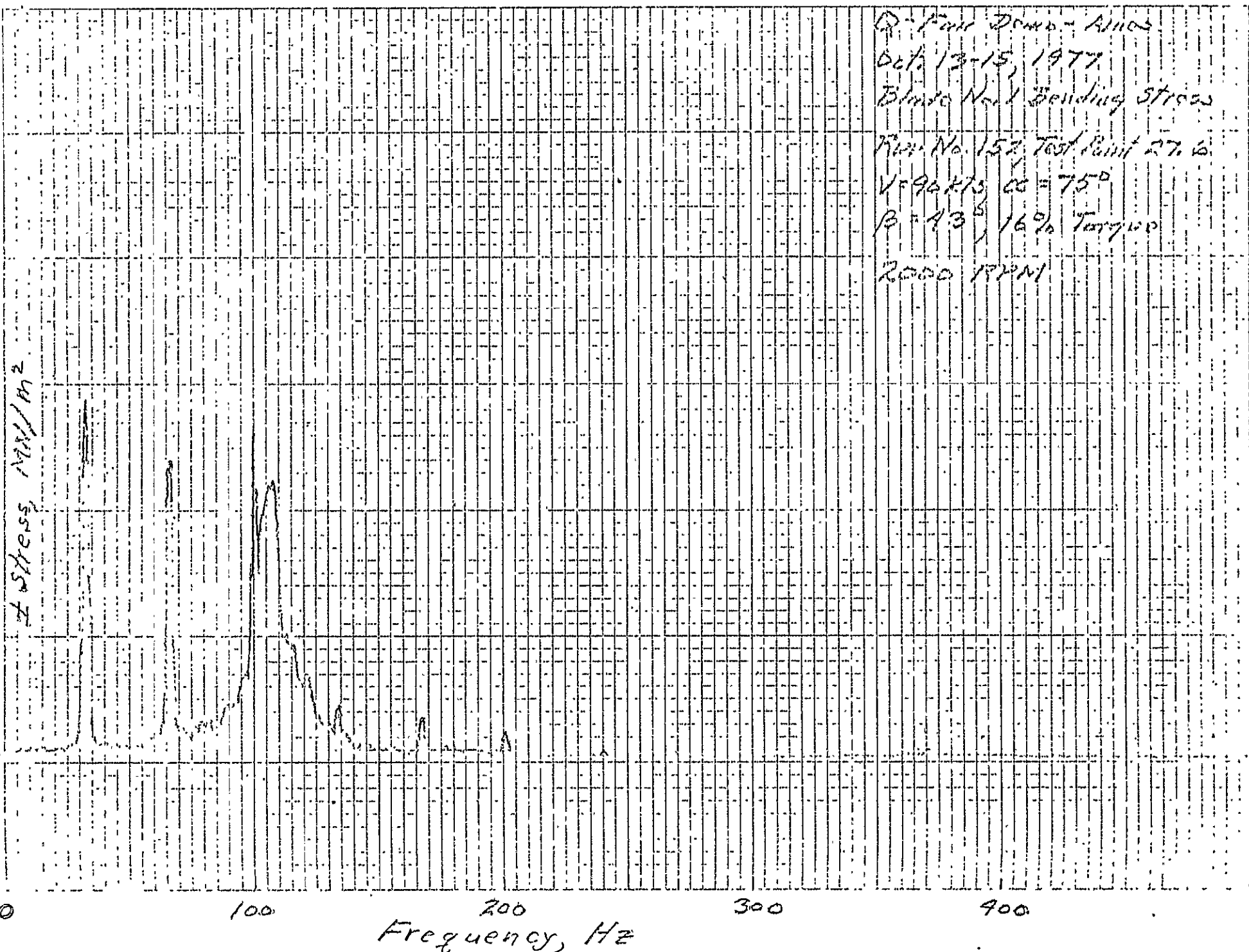
4

2

0

77

Stress, MPa / Hz²



Q - Fair Demo - Almas
Oct. 13-15, 1977
Blind Nail Bending Stress
Nail No. 152, Test Point 27.6
 $V = 90 \times 15$, $\alpha = 75^\circ$
 $B = 43^\circ$, 16% Torque
2000 RPM

Q-Fair Demo - Amos
Oct. 13-15, 1977
Blade No. 1 Bending Stress

Run No. 153, Test Point 27.7
 $V = 90 \text{ Kts}$, $\alpha = 75^\circ$
 $\beta = 52^\circ$, 32% Torque

2000 RPM

4

2

0

86

Bending Stress, MN/m^2

100

200

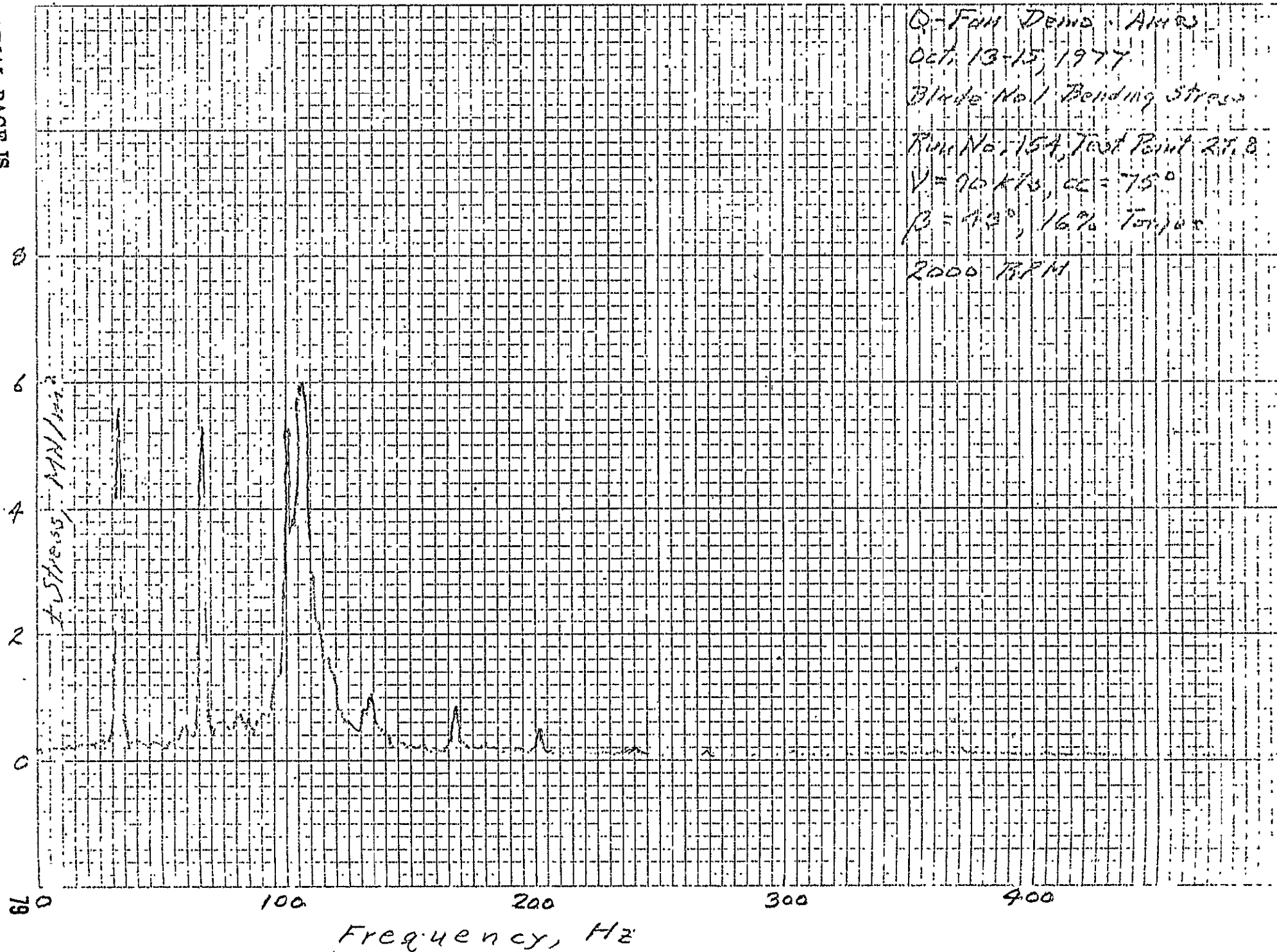
300

400

Frequency, Hz

Blade No. 1

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Q-Fin Drive - Aired

Oct. 13-15, 1977

Blade No. 1 Bending Stress

Run No. 164, Test Run # 30.1

V = 40 knots, $\alpha = 120^\circ$

$\beta = 56^\circ$, 97% Torque

3150 RPM

10

8

6

4

2

0

08 0

100

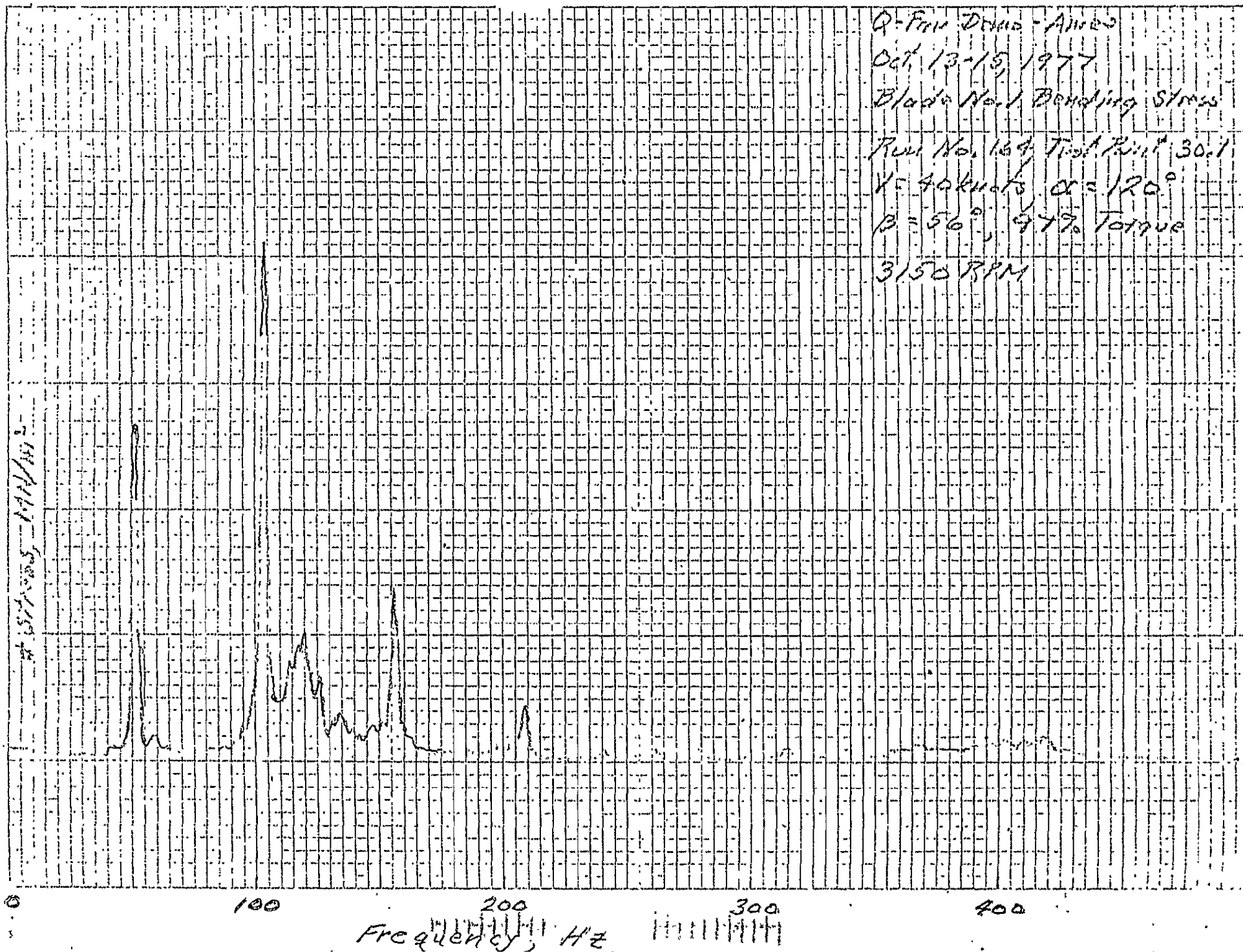
200

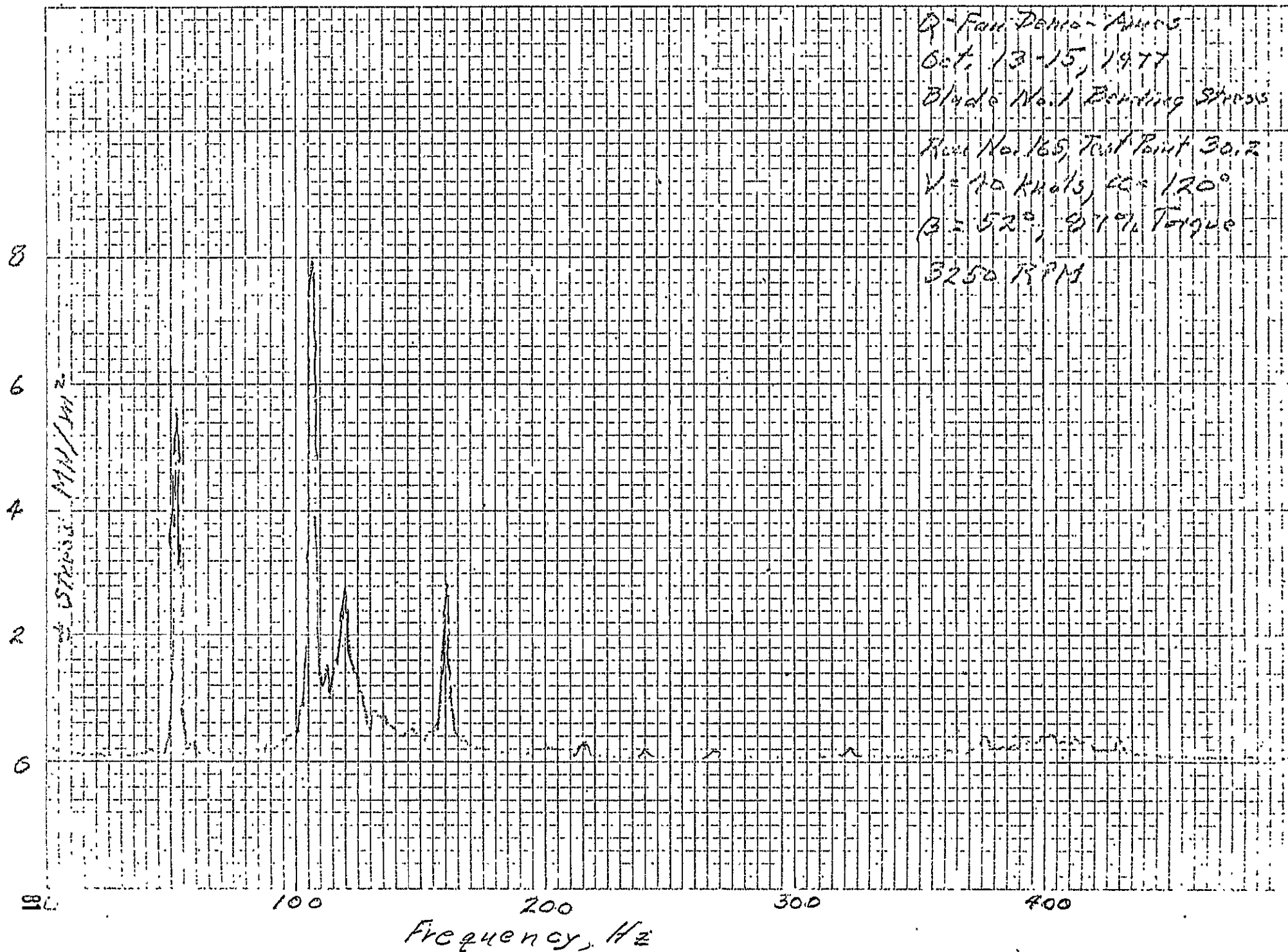
300

400

Frequency, Hz

Strokes, MIN/IN²





12

10

8

6

4

2

0

82

PEAK AT 18 MN/M²

Q-Fair Demo - Aime

Oct. 13-15, 1977

Blade No. 1 Bearing Stress

Run No. 170, Test Point 20.7

V = 40 knots, $\alpha = 120^\circ$ $\beta = 52^\circ$, 46% Torque

2300 RPM

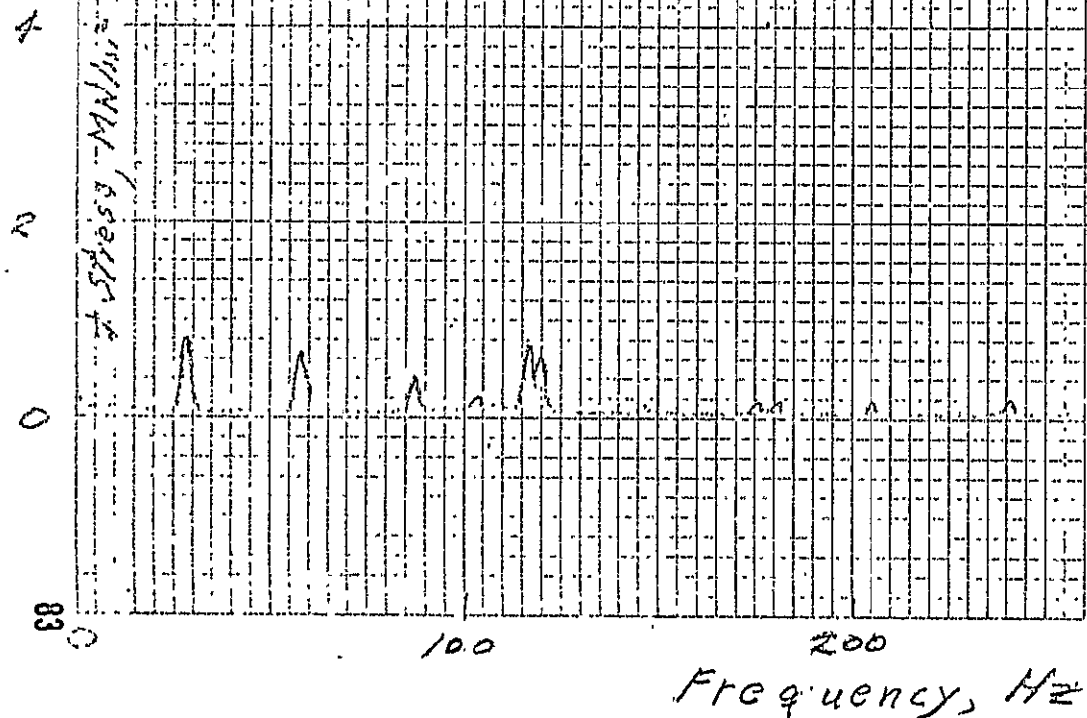
Stress, MN/M²

0.2% Stress Peak

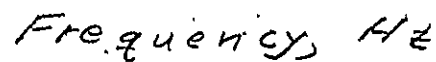
Frequency, Hz

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Q-Fry, Demo - Ames
Oct. 13-15, 1977
Blade No. 1 Bending Stress
Row No. 173, Test Point 31.1
 $V = 90 \text{ km/h}$, $\alpha = 70^\circ$
 $\beta = 52^\circ$, 24% Torque
17.50 RPM



1250 RPM



Q - Fat. Demo - Alcoa
Oct 13-15, 1977
Plane Nail Bending Stress

Run No. 175, Test Point 31.3
 $V = 90$ kmps, $\alpha = 78^\circ$
 $\beta = 52^\circ$, 24% Torque

1750 KPM

344/1114 67-16545

Frequency, Hz

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OF POOR QUALITY

85
0

Q-Fan Del.

Oct. 13-15, 1977

Blade No. 1 Bearing Stress

Rule No. 176, Test Point 31.1

$V = 90$ knots, $\alpha = 81^\circ$

$\beta = 52^\circ$, 24% Taper

1756 RPM

8

6

4

2

0

98

Stress, MN/m²

100

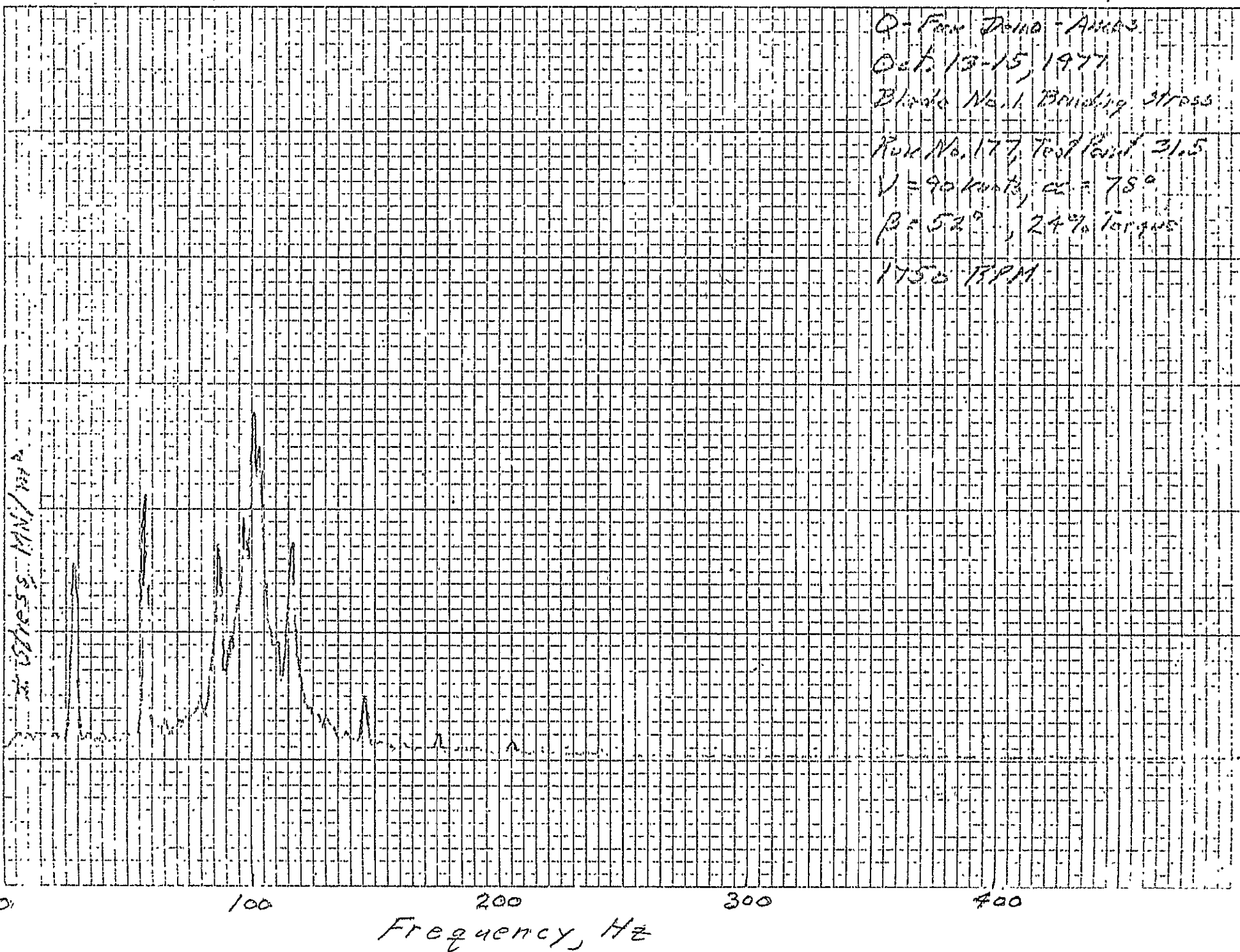
200

300

400

Frequency, Hz

Q-Four Demo - Aero 3
Oct. 13-15, 1977
Blade No. 1 Bonding Stress
Run No. 177, Test Point 31.5
 $V = 90 \text{ knots}$, $\alpha = 75^\circ$
 $\beta = 52^\circ$, 24% Torque
1750 RPM



Q-Ferr. Doria - Punta
Oct. 13-15, 1977
Blade No. 1 Bending Stress
Run No. 178, Test Part 31.6
 $V = 90$ Knts, $\alpha = 75^\circ$
 $\beta = 52^\circ$, 240° Torque
1750 RPM

7

10

0

88

Bending Stress, MN/m²

Frequency, Hz

0

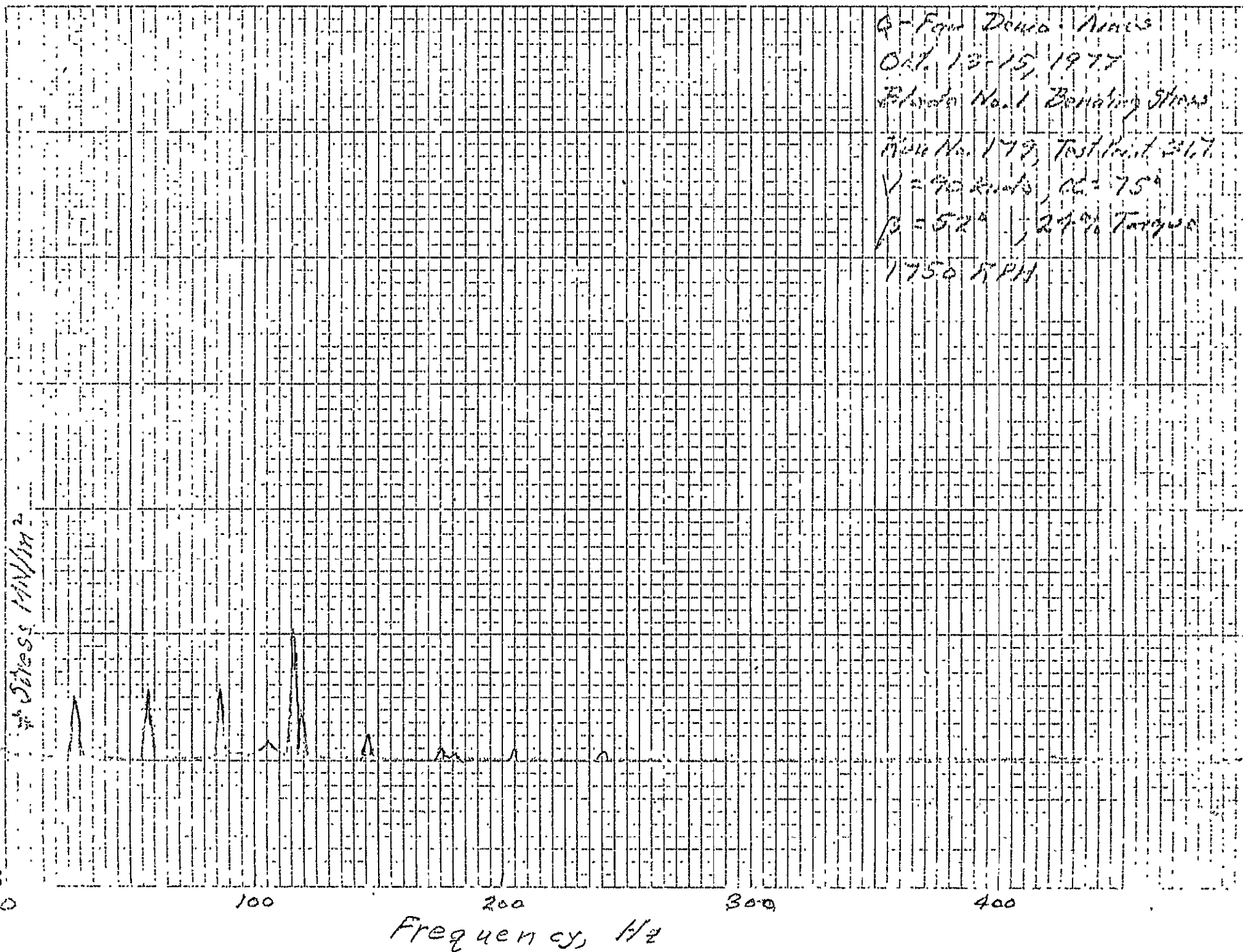
100

200

300

400

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APPENDIX B

TAPE RECORD LOGS

DATE 9-15-77) _____

TAPE REEL NO. 1

SHEET 5

TEST NO. _____

TAPE REC. MODEL HONLWELL 5600C HEAD STACK 1 R 1 G AMP. GAIN

TEST ENGR.

TAPE SPEED 3 3/4 TEST LOCATION NASA AMES

INSTRUMENTATION ENGR. Dinick VOICE TK. NO. Edge track TIME CODE TK. NO. 12

[illegible]

[illegible]

DATE 9-19 C-2

TAPE REEL NO. 3

SHEET 1 OF 1

TEST NO. 4/CFA

TAPE REC. MODEL HONEYWELL 5600 C

HEAD STACK 1R1G

AMP. GAIN

TEST ENGR.

TAPE SPEED

3 3/4 IPS

TEST LOCATION NASA - AMES

INSTRUMENTATION ENGR.

Dimick

VOICE TK. NO.

EDGE

TIME CODE TK. NO.

14.

[illegible]

SAFE RECORD LOG

DATE 9-21-77) TAPE REEL NO. 6) SHEET 1 F 1

TEST NO. L/CFA TAPE REC. MODEL HONEYWELL 5600 C HEAD STACK 1R16 AMP. GAIN

TEST ENGR. TAPE SPEED 3 3/4 TEST LOCATION NASA-AMES 40 x 80

INSTRUMENTATION ENGR. Dimick VOICE TK. NO. EDGE TIME CODE TK. NO. 14

RUN NO.	COND.	START TIME	TK 1	TK 2	TK 3	TK 4	TK 5	TK 6	TK 7	TK 8	TK 9	TK 10	TK 11	TK 12	TK 13
18	1-2	18.47.00 19.03.27	1	1	1	1	1	1	1	1	1	1	3	-10dB	1
CAL	9-21-77	19.04.00 19.06.30	1Vrms @ 400Hz, -1.4VDC, 0VDC, +1.4VDC												
19	1-10	00.17.10 ↓ : ↓ : ↓	}	}	}	}	}	}	}	}	}	}	}	}	}
20	1-17	↓ : ↓ : ↓ 01.50.40	}	}	}	}	}	}	}	}	}	}	}	}	}
CAL	9-22-77	15.54.00 15.56.30	1Vrms @ 400Hz, -1.4VDC, 0VDC, +1.4VDC												
		: : :	END OF REEL #6												
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DATE 7-22-77

TAPE REEL NO.

SHEET

TEST NO. L/CFA

TAPE REC. MODEL HONEYWELL 5600 C HEAD STACK 1R16

AMP. GAIN $\angle$ LINEAR

TEST ENGR.

TAPE SPEED 3 3/4 105

TEST LOCATION NASA-AMES

INSTRUMENTATION ENGR.

Dimick

VOICE TK. NO.

EDGE

TIME CODE TK. NO. 14

[illegible]

SHEET, OF

TAPE REC. MODEL HON. 5600C HEAD STACK IRIS AMP. GAIN LINEAR

TEST ENGR. W. SHAIN TAPE SPEED 3 3/4 IPS TEST LOCATION NASH/AMES 401821

INSTRUMENTATION ENGR. ROY BINGO VOICE TK. NO. EDGE "A" TIME CODE TK. NO. 14 (A-1)

[illegible]

ORIGINAL PAGE IS
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TAPE RECORD LOG			
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
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99	99	99	99
100	100	100	100

DATE _____

TAPE REEL NO. 9

SHEET F

TEST NO. 513

TAPE REC. MODEL HON. 5600C HEAD STACK JRIG AMP. GAIN LIVE

TEST ENGR. W. SHAIN

TAPE SPEED 3 3/4 T.P.S TEST LOCATION NASA/AMES 40' X 80'

INSTRUMENTATION ENGR. ROY BINGO VOICE TK. NO. EDGE "A" TIME CODE TK. NO. 14 (Fm)

[illegible]

APPENDIX C

FINAL DATA

PRECEDING PAGE BLANK NOT FILLED

APPENDIX D

TEST LOGS

PRECEDING PAGE BLANK NOT FILLED

REC.	CHK.	APPROVED	APPROVED	TEST LOG	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T70 °F	Vt Kts/q	α DEG	PAMB * IN/Hg	DATE - TIME
					1.1	COMPLETE 5597-1 NACELLE	C/O	-	52	4630	70	0	0	29.824	9-15 1805
					2.1	OVSPD C/O -	C/O		✓	4550	69	✓	✓	29.878	9-16 1740-20
					2.2	OUTORK SHUTDOWN	C/O		✓	4720	70	✓	✓	✓	1750
					3.1	STATIC RUN	2B	1	56	15000	70	✓	✓	29.891	1812
					3.2	✓	✓	2	51.9	14270	71	✓	✓	✓	1815
					3.3	✓	✓	3	✓	12670	73	✓	✓	✓	1817
					3.4	✓	✓	4	✓	10850	74	✓	✓	✓	1819
					3.5	✓	✓	5	✓	9140	75	✓	✓	✓	1822
					3.6	✓	✓	6	43	8430	76	✓	✓	✓	1824

* CONVERSION CONST = .49116 ~~1/IN~~ IN. Hg

- 1 ▷ RAN UP TO IDLE - TOOK C/O DATA PT. FOR DATA REDUCTION C/O
- 2 ▷ C/O LYCOMING OVERSPD PROTECTION SYSTEM - DID NOT WORK
- 3 ▷ C/O HAM STD OVERSPD SYSTEM - O.K. ENGINE SHUT DOWN AUTO.
- 4 ▷ C/O LYCOMING OSPD SHUTDOWN OK
- 5 ▷ C/O OUTORK SHUTDOWN - O.K.
- 6 ▷ RECORDED TRANSIENT SHUTDOWN FOR NASA - LORC
- 7 ▷ N_1 N_2 INPUTS NOT CONNECTED TO DATA SYSTEM DURING RUN 3
- 8 ▷ S/V'S OUT OF SYNC. BAD DATA
- 9 ▷ DATA FILE DAMAGED IN SYSTEM - NO DATA

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BOEING

NO. 105
PAGE

REC.	CHK	APPROVED	APPROVED	TEST LOG	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{70} OF	V_T KTS/4	α DEG	P AMB IN HG	DATE - TIME
					4.1	CONFIG 1 L/CFA FAN INLET	1		43°	8270	70	40.35 5.4	90	29.884	9-16 2114
					4.2	✓	✓		✓	8230	✓	37	115	✓	2122
					4.3	✓	✓		✓	8160	✓	36	120	✓	2125
					5.1	✓	✓		✓	8370	72	78.90 19	70	✓	2145
					5.2	✓	✓		✓	8400	✓	75	✓	✓	2152
					5.3	✓	✓		✓	8340	✓	75	75	✓	2155
					5.4	✓	✓		51.8	7830	✓	75	78	✓	2207
					5.5	✓	✓		✓	7780	73	75	81	✓	2209
					5.6	✓	✓		✓	9090	74	75	91	✓	2227
					5.7	✓	✓		✓	9020	75	71	94	✓	2229

1 ▷ NOT START. 1ST ATTEMPT ABORTED

2 ▷ INLET SEPARATED AT 88° (TIME 2211) RETRACED α TO 78°-80° BEFORE REATTACHMENT. SOUND OF ENGINE (INLET) CHANGED; PDF2 STEPPED UP, VIB. STEPPED UP, BLADES STRESS JUMPED UP, WHEN INLET SEPARATED. (FAN STALL?)

3 ▷ REDUCED DATA STILL HAS BAD N_2 , β , PLA, TORQ RUN 3 HAS BAD PTT

4 ▷ ~~DATA QUESTIONABLE S/V B & F HAVE 0.3 PS DRIFT?~~

5 ▷ S/V'S OUT OF SYNC BAD DATA

BOEING

NO.
PAGE

106

APPROVED	APPROVED	CHK	REC.	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{70} °F	V_T KSS/8	α DEG				P AMB	DATE TIME
				6.1	L/CFA FAN INLET	1		43°	8720	84	105/41	51				14.671	9-19 1805
				6.2		1		✓	8740	✓	107	53				✓	1807
				6.3		1			✓	85	✓	55				✓	1809
				6.4		1		51.8	8240	86	106	62				✓	1817
				6.5				✓	8220	✓	✓	65				✓	1819
				6.6				✓	8190	✓	105	66				29.98	1821
				6.7				✓	10820	90	103	77				✓	1831
				6.8				✓	10800	91	104	80				✓	1837
				6.9				✓	12620	92	102	85				✓	1846
				6.10				✓	12530	93	100	92				✓	1849

TEST LOG

BOEING

NO.
PAGE 107

1 CHECKED LYCOMING OVSPD SHUTDOWN OK

~~2 BAD DATA S/V'S OUT OF SYNC~~

ORIGINAL PAGE IS
OF POOR QUALITY

REC.	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β	N_2	T_{70}	V_T	α				PAMB		DATE
					DEG	RPM	OF		KTS/SEC						
APPROVED	6.11	L/CFA FAN INLET	1	1	51.8	12480	93	101.41	95				29.88		9-19/851
	7.1	↓	1	AV	43	7660	93	147.72	40			▷	✓		1909
	7.2		1	AW	✓	8810	94	146	44			✓		1916	
APPROVED	7.3		1		✓	8800	✓	141	45				✓		1918
	7.4		1	AW	51.8	8390	95	141	50				✓		1926
	7.5		1		✓	8370	96	139	52				✓		1932
APPROVED	7.6		1	AW	✓	10740	✓	139	59				✓		1938
	7.7		1	✓	✓	10720	✓	✓	61				✓		1940
	7.8		1	AW	✓	12640	98	137	67				✓		1944
BO	7.9		1	✓		12640	✓	138	68				✓		1949

▷ COULDN'T GET 154/sec/ft² BECAUSE OF $\frac{9}{8}$

REC.	CHK	APPROVED	APPROVED	TEST LOG	DATE	REVISED	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{70} OF	V_1 KTS/2	α DEG	PAMB IN. HG	DATE - TIME
							8.1 PRIORITY II RUNS	2B	2	51.8	14330	75	15 18.8	0	29.94 14.705	9-19 2253
							9.1 L/CFA FAN INLET	✓	✓	✓	14670	76	74 19	0	29.96 14.715	2359
							9.2	✓	3	✓	12980	77	74	✓	✓	9-20 0003
							9.3	✓	4	✓	10960	78	✓	✓	✓	0005
							9.4	✓	5	✓	9370	✓	75	✓	✓	0009
							9.5	✓	6	43	8060	78	✓	✓	✓	0015
							10.1	2B	2	51.8	14190	✓	✓	60	✓	0022
							10.2	✓	3	✓	12990	80	✓	✓	✓	0027
							10.3	✓	4	✓	10380	✓	✓	✓	✓	0030
							10.4	✓	5	✓	8770	✓	✓	✓	✓	0034

1 S/V's OUT OF SYN. RETOOK PT. - S/V's OUT COMPLETELY ABORTED RUN NO DATA

ORIGINAL PAGE IS
OF POOR QUALITY

BOEING

NO. 109
PAGE

REC.	CHK	APPROVED	APPROVED	DATE	TEST LOG	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{70} °F	V_T KTS/q	α DEG	P_{AMB} IN HG	DATE TIME
						10.5	L/CFA FAN INLET	2B	6	43	784	80	75	60	29.96	9-20 0038
						11.1			2	51.8	14290	81	✓	75	✓	0043
						11.2			3	✓	12610	82	✓	✓	✓	0051
						11.3			4	✓	10130	83	✓	✓	✓	0054
						11.4			5	✓	7630	✓	✓	✓	✓	0057
						11.5			-	43	9460	✓	✓	✓	✓	0101
						11.6			-	✓	9170	✓	✓	✓	✓	0103
						12.1			2	51.8	14150	85	105/38	0°	29.97 14.72	0115
						12.2			3	✓	12920	✓	✓	✓	✓	0119
						12.3			4	✓	10820	88	✓	✓	✓	0123

- 1 S/V HANGING UP - SEEMS TO HANG UP EVERYTIME AT HIGH POWER CONDITION
- 2 NO DATA. S/V'S OUT OF STEP.

BOEING

NO. 110
PAGE

BOEING

2 S/V "D" HAS .010 PSI DRIFT DURING SCAN

ORIGINAL PAGE IS
OF POOR QUALITY

APPROVED	APPROVED	CHK	REC	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N ₂ RPM	T ₇₀ OF	V _T K ₈ /S	α DEG				PAGE		DATE — TIME
				13.9	L/CFA FAN INLET	2C	10	4/3	13710	82	75	90					30.02	9-20 1953
				13.10		✓	12	✓	11720	✓	✓	✓					14.745	1957
				13.11		✓	—	✓	11520	✓	✓	✓					✓	2000
			REVISED	13.12		✓	—	✓	11000	✓	✓	✓				1	✓	2002
				14.1		2B	2	5/8	13990	76	104	60				2	30.04 14.754	2213
			DATE	14.2		✓	3	✓	12410	77	✓	✓				3	✓	2216
				14.3		✓	4	✓	9670	✓	✓	✓					✓	2219
TEST LOG	BO			14.4		✓	5	✓	8980	78	✓	✓					✓	2222
				14.5		✓	5A	✓	7860	✓	✓	✓				4	✓	2225
				14.6		✓	5B	✓	7550	✓	✓	✓					✓	2227

1 STARTED TO DECREASE RPM PDF1, 2, 3 INCREASED ALONG WITH β . STRESSES. INLET IS APPARENTLY SEPARATED SHUT ENGINE DOWN

2 BAD DATA S/V'S OUT OF SYNC.

3 S/V D HAS +.010 DRIFT DURING SCAN

~~4 S/V E HAS .012 DRIFT DURING SCAN~~

BOEING

NO. 112
PAGE

REC	CHK	APPROVED	APPROVED	DATE	TEST LOG	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{T0} °F	V_T KTS/8	α DEG	PAMB IN HG	DATE - TIME
						14.7	L/CFA FAN INLET	ZB	5C	51.8	7370	78	105	60	30 04	9-20 2230
						15.1		ZC	2	56	13670	81	✓	75	✓	2236
						15.2			3	51.8	13320	82	✓	✓	✓	2240
						16.1		ZC		56	13670	88	105	75	29.86 14.666	9-21 1757
						16.2		✓		57.8	13150	91	✓	✓	✓	1759
						16.3		✓		✓	12210	92	✓	✓	✓	1802
						16.4		✓		✓	11330	✓	✓	✓	✓	1805
						16.5		✓		✓	10560	✓	✓	✓	✓	1807
						16.6				✓	10370		✓	✓	✓	1810

1 ▷ 2242. CHIP LIGHT ON #3 BROUGHT α BACK & STARTED DOWN IN RPM WHEN LIGHT CLEARED - ~~RESUMED ROTATING~~ LIGHT BACK ON - SHUT DOWN

2 ▷ CHECKED N_2 SUPPLY - BOTH BOTTLES AT 2000 PSI

3 ▷ CHECKED LYCOMING OVSPD OK

~~4 ▷ BAD DATA S/V'S OUT OF SYNC.~~

BOEING

NO. 113
PAGE

ORIGINAL PAGE IS
OF POOR QUALITY

REC	CHK	APPROVED	APPROVED	DATE	TEST LOG	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{70}	V_T KB/9	α DEG	P_{AMB} IN HG	DATE — TIME
						17.1	L/CFA FAN INLET	2C		52	13320	94	125/50	60	29.84	9-21 1817
						17.2				51.8	12770	95	124	✓	✓	1820
						17.3				✓	12030	✓	✓	✓	✓	1823
						17.4				✓	11250	95	✓	✓	✓	1829
						17.5				✓	10400	96	✓	✓	✓	1831
						17.6				✓	9700	✓	✓	✓	✓	1833
						17.7				✓	9090	✓	✓	✓	✓	1837
						17.8				✓	8690	✓	✓	✓	✓	1841
						18.1		2C	2	56	14250	98	142	0	29.85 14.661	1854
						18.2			3	51.8	14030	✓	✓	✓	✓	1858

- 1 HAD TO RETAKE TUNNEL DATA (PT3) AT PT. 4 ENGINE CONDITIONS. PT3 FORCE DATA NG
- 2 S/V HUNG UP RETOOK
- 3 FRONT FRAME TEMPS READING HIGH. SHUTDOWN TO CHECK

BOEING

NO.
PAGE

114

REC	CHK	APPROVED	APPROVED	REVIS	DATE	TEST LOG	BOEING	NO.	PAGE	115
RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{70} °F	V_T KTS/9	α DEG	P_{AMB} IN HG	DATE — TIME
19.1	L/CFA FAN INLET	2C	4	51.8	12350	70	140/66	0	29.85 14.663	9-22 0024
19.2			5	✓	11600	72	✓	✓	✓	0027
19.3			6	✓	10800	75	✓	✓	✓	0029
19.4			7	✓	9350	✓	✓	✓	✓	0032
19.5			8	✓	8550	78	✓	✓	✓	0034
19.6			8	✓	✓	✓	✓	✓	✓	0036
19.7			9	✓	8000	78	✓	✓	✓	0039
19.8			-	✓	7270	79	✓	✓	✓	0042
19.9			-	✓	6000	80	✓	✓	✓	0045
19.10			✓	✓	5500	✓	✓	✓	✓	0047

- 1 ENG. FRT FRAME RT ENG COMPRES. FRT LFT COMP REAR LEFT TEMPS NOT WORKING
- 2 TTM 3 WENT OPEN - TGED ON DATA SYSTEM TO TTM 2
- 3 AIRFLOW UNSTABLE

ORIGINAL PAGE IS
OF POOR QUALITY

REC.	CHK	APPROVED	APPROVED	DATE	TEST LOG	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{70} OF	V_T KTS/19	α DEG	P_{AMB} IN HG	DATE — TIME
						20.1	L/CFA FAN INLET	2C		56	14100	84	140	45	29.85	9-22 0055
						20.2				51.8	13200	✓	✓	✓	14.66	0100
						20.3				✓	12150	87	✓	✓	✓	0103
						20.4				✓	11500	✓	✓	✓	✓	0105
						20.5				✓	10700	88	✓	✓	✓	0107
						20.6				✓	9240	✓	✓	✓	✓	0110
						20.7				✓	8670	88	✓	✓	✓	0113
						20.8				✓	7990	✓	✓	✓	✓	0116
						20.9				✓	7260	✓	✓	✓	✓	0120
						20.10				✓	6430	✓	✓	✓	✓	0122

BOEING

NO.
PAGE

116

REC	CHK	APPROVED	APPROVED	TEST LOG	RUN NO.	CONFIGURATION	TYPE OF RUN	P ₀₁₄	β	N ₂	T ₁₀	V _T	Q	P _{AMB}	DATE
								DEG	RPM	°F	Kts/10	DEG			TIME
					20.11	L/CFA FAN INLET	20	14-600	43	13880	88	140	45	29.85 14.6	9-22 0128
					20.12			12-500	✓	11500	89	✓	✓	✓	0130
					20.13			13-900	✓	10830	90	✓	✓	✓	0133
					20.14			14-800	✓	9460	✓	✓	✓	✓	0137
					20.15			-	✓	9060	✓	✓	✓	✓	0139
					20.16			-	✓	8670	✓	✓	✓	✓	0142
					20.17			-	✓	8440	✓	✓	✓	✓	0146
					21									29.85 14.66	9-22 1700

1 LYCOMING OVSPD CHECK OK.

2 WIND TUNNEL DRIVE MOTORS WOULD NOT SYNC. ELECTRICAL PROBLEM IN ONE OF THE LARGE M-G SETS 1-2 WEEKS REPAIR

ORIGINAL PAGE IS
OF POOR QUALITY

BOEING

NO.
PAGE

117

APPROVED	APPROVED	CHK	REC.	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β	N_2	T_{70}	V_T	α				PANE	DATE
							IN	DEG	RPM	°F	KTS/°	DEG				IN HG	TIME
				22	L/CFA FAN INLET. W/T MG SET REPAIRED	2B	-	52	-	90	60	75	▷	▷	▷	29.93 14.70	10-13 1715
				23.1				✓	14170	83	✓	✓		▷		29.98 14.725	10-14 1808
				23.2				✓	11880	85	✓	✓					1814
				23.3				✓	9250	87	✓	✓					1816
				23.4				✓	7090	✓	✓	✓					1829
				23.5				43	8030	✓	✓	✓		▷			1836
				24.1				52	14350	74	✓	90		▷		30.03 14.75	10-14 2113
				24.2				✓	12500	78	✓	✓		✓		✓	2116
				24.3				✓	10650	✓	✓	✓		✓		✓	2119
				24.4				✓	8820	✓	✓	✓		✓		✓	2121

TEST LOG

BOEING

NO. 118
PAGE

- (SMALL AMOUNTS)
- ▷ PTC 18, 24, 23, 22, 25 & 26 APPEAR TO HAVE RESIDUAL PRESSURE TRAPPED IN LINES (.3, .16, .01, .14, .03, .03) psi + VISUALLY CHECKED RAKES, APPEAR OK
 - ▷ LYCOMING OVSPD CHECK OK
 - ▷ LOST N_2 SIGNAL RUN ABORTED NO DATA
 - ▷ STILL HAVING N_2 PROBLEMS. SHUT DOWN TO TROUBLE-SHOOT PROBLEM APPEARS TO BE ILS SYSTEM
 - ▷ DRAG & YAW MOMENT DATA RECORDED MANUALLY QUICK LOSS DATA N.G
 - ▷ PTC 21, 23 & 24 HAVE RESIDUAL PRESSURE TRAPPED (.15 -.25 psi) DATA VALUES HAVE BEEN REPLACED IN COMPUTER PROGRAM WITH PTC 16, 17 & 18 VALUES -RESPEC. RUNS 23. & ON

BOEING

119
NO.
DATE

ORIGINAL PAGE IS
OF POOR QUALITY

REC	CHK	APPROVED	APPROVED	REVIS	DATE	TEST LOG	BOEING	NO.	PAGE	120
RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	Nz RPM	T ₁₀ OF	V _T KTS	α DEG	P _{AMB} IN/Hg	DATE — TIME
26.1		2B	1	52	14 ₂₀₀	32	90	60	30.04	10-14 2211
26.2				✓	12 ₂₀₀	✓	90	60	✓	2220
26.3				✓	10 ₂₃₀	83	✓	✓	✓	2224
26.4				✓	8 ₁₂₀	83	✓	✓	✓	2227
26.5				43	85 ₃₀	✓	✓	✓	✓	2231
26.6				✓	8 ₁₈₀	✓	✓	✓	✓	2233
26.7				✓	7 ₉₀	✓	✓	✓	✓	2236
26.8				✓	65 ₀₀	82	✓	✓	✓	2240
27.1				52	14 ₁₃₀	83	✓	75	30.05 14.759	2247
27.2				✓	125 ₄₀	✓	✓	✓	✓	2250

△ (△ RUN 25)

REC	CHK	APPROVED	APPROVED	TEST LOG	DATE	REVISED	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{TO} OF	V_T KTS	α DEG				P_{AMB} IN. HG	DATE — TIME
									52	10060	83	90	75	1			14.759	10-19-2254
									✓	8730	✓	✓	✓	✓			✓	2257
									✓	7890	✓	✓	✓	✓	2		✓	2300
									43	9530	✓	✓	✓	✓	2		✓	2302
									52	9550	✓	✓	✓	✓	2		✓	2304
									43	9550	✓	✓	✓	✓	2		✓	2307
									✓	11100	✓	✓	✓	✓	3		✓	2310
									52	14130	84	90	90	✓			✓	2316
									✓	12660	✓	✓	✓	✓			✓	2318
									✓	11500	✓	✓	✓	✓			✓	2321

1 (11 RUN 25)

2 IN "STALL" LIP FLOW SEPARATED W1, WK1, CALC N.G. USE W2, W3 FOR INLET FLOW

3 OUT OF "STALL"

ORIGINAL PAGE IS
OF POOR QUALITY.

BOEING

NO. 121
PAGE

REC.	CHK	APPROVED	APPROVED	TEST LOG	DATE	REVISED	CONFIGURATION	TYPE OF RUN	POINT	ϕ DEG	N_2 RPM	T_{70} OF	V_t KPS/4	α DEG	PAMB IN HG	DATE TIME
								2B		52	11130	85	90	90	30.05	10-14 2324
										✓	10500	✓	✓	✓	✓	2326
										52	15120	✓	40	✓	✓	2335
										✓	11300	✓	✓	✓	✓	2339
										✓	19120	86	✓	✓	✓	2342
								2C		56	14840	✓	40	120	✓	2353
										52	15270	87	✓	✓	✓	2358
										✓	14250	✓	✓	✓	✓	10-15 0000
										✓	13550	88	✓	✓	✓	0002
										✓	12840	✓	✓	✓	✓	0004

 (1) RUN 25)
 MAX LIMITS NI & TT7

BOEING

NO. 122
PAGE

BOEING

TEST LOG

① (① RUN 25)

2. N_2 DRIFTED AT HIGH RPM LYCOMING OVSP TRIPPED NO DATA 30.10

3 LYCOMING OVSPD CHECK OK

4. IN "STALL" LIP FLOW SEPARATED IN1, WK1 CALC. N.G. USE W2, W3 FOR INLET FLOW

ORIGINAL PAGE IS
OF POOR QUALITY

APPROVED	CHK	REC.	RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	β DEG	N_2 RPM	T_{T0} °F	V_T KTS	α DEG				P_{AMB} IN HG	DATE TIME
			31.6		1		52	9320	80	90	75	∇^2			14.764	10-15 1334
			31.7				✓	✓	✓	✓	✓	∇	∇		✓	1335
			32.1				43	9240	83	125 92.5	48				✓	1344
			32.2				✓	9230	84	122	50				✓	1346
			32.3				✓	9240	85	✓	52				✓	1349
			32.4				✓	9260	✓	121	53.5				✓	1351
			32.5				52	9950	86	✓	59				✓	1355
			32.6				✓	9030	88	✓	60				✓	1402
			32.7				✓	✓	89	✓	62				✓	1407
			32.8				✓	✓	90	✓	64				✓	1411

TEST LOG

BOEING

NO.
PAGE

124

∇ OUT OF "STALL"

∇ RETAKE OF 31.6 FLOW REATTAINED DURING 31.6 DATA SCAN

BOEING

ORIGINAL PAGE IS
OF POOR QUALITY

APPROVED	APPROVED	CHK	REC.	RUN NO.	CONFIGURATION	TYPE OF RUN	P ₀₁₄	φ	N ₂	T ₇₀		V _T	α				P _{AMB}	DATE
								DEG	RPM	°F		KTS/°	DEG				IN. HG	TIME
				32.19		1		56	14 ₃₂₀	100		118	75	▷			30.04	10-15 1446
				32.20				✓	14 ₃₆₀	✓		117	81				✓	1450
				32.21				✓	14 ₃₀₀	✓		116	84	▷			✓	1452
			REVISED	33.1				✓	14 ₆₀	104		149/63	70	▷			✓	1508
				33.2				✓	✓	105		✓	71	▷	▷		✓	1508
			DATE	34.1				43	8 ₁₄₆	95		160	39				30.03	10-15 1615
				34.2				✓	8 ₁₅₀	98		✓	41				14.750	1618
			TEST LOG	34.3				52	9 ₅₆₀	99		✓	45				✓	1622
				34.4					✓	9 ₆₀₀	100		155	50			✓	1624
				34.5					✓	✓	101		✓	52			✓	1626

1 SIDE FORCE SCALE AT LIMIT

2 ABORTED SCAN - RETAKE

3 SIDE SUPPORT CABLE ON STRUT FAIRING BROKE (EYE BOLT). FAIRING BUFFETING SHUT DOWN

ORIGINAL PAGE IS
OF POOR QUALITY

RUN NO.	CONFIGURATION	TYPE OF RUN	POINT	B DEG	N ₂ RPM	T ₇₀ OF	V _T $\frac{KTS}{Q}$	α DEG	P _{AIR} IN HG	DATE - TIME
34.6		1		52	12730	102	157	45	4.750	10-15 1629
34.7				✓	1280	104	155	57	✓	1631
34.8				✓	✓	✓	✓	59	✓	1633
34.9				✓	12700	✓	✓	61	30.02	1636
34.10				56	13300	106	158	45	14.745	1639
34.11				✓	13360	✓	155	61	✓	1642
34.12				✓	13390	108	✓	63	✓	1644
35.1		2A		52	13920	✓	140/62	20	✓	1651
35.2				✓	10050	✓	142	✓	✓	1654
35.3				43	7380	106	140	✓	✓	1657

25

TEST LOG

REC		REVISED	DATE
CHK			
APPROVED			
APPROVED			

BOEING

NO. 127
PAGE

REC	CHK	APPROVED	APPROVED	DATE	REVISED	TEST LOG	BOEING	NO.	PAGE
RUN NO.	CONFIGURATION	TYPE OF RUN	ϕ DEG	N_2 RPM	T_{TO} °F	V_T KT/9	α DEG	P_{AMB} IN. HG	DATE — TIME
36.1		2B	52	14240	107	140	60	14.745	16-15 1704
36.2			✓	11730	✓	✓	✓	✓	1707
36.3			✓	11270	✓	✓	✓	✓	1709
36.4			✓	10090	108	✓	✓	✓	1711
36.5			✓	9910	✓	✓	✓	✓	1714
37.1			52	13950	102	105	20	✓	1734
37.2			✓	10500	✓	✓	✓	✓	1737
37.3			43	6610	✓	✓	✓	✓	1739
38.1			52	14450	✓	75	✓	✓	1747
38.2			✓	10880	✓	✓	✓	✓	1750
38.3			43	8020		✓	✓	✓	1752

NASA AMES WIND TUNNEL TEST

[illegible]

64

SEPT 16, '77

2

Q FAN DEMONSTRATOR"

ENGINEERING LOG

[illegible][illegible]

1

10/1/20

$n = 280$

SHEET NO. 3

4.1 YALU TO 120° α

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
	2101	START	139	10120	5640	800	43	14	53	50	4	30	105	106	10.5	40	64
4.1	2106			12740	8220	840	43	41	64	60	11	20	107	118	10.5	40	
	2113			12790	8290	830	43	41	64	76	12	28	110	132	13	51	90°α
	2123			12800	8230	830	43	41	60	80	12	28	117	137	14	51	115°α
	2124			12790	8160	830	43	41	60	80	12	28	120	138	14	51	120°α
5.1	2139			12540	8220	820	43	33	59	81	11	28	131	145	15	51	0°α
5.2	2153			12530	8370	825	43	33	59	81	11	28	134	147	15	52	70°α
5.3				12530	8300	825	43	33	59	81	10.5	28	137	149	15	51	75°α
5.4	2204			13670	7840	835	52	46	63	84	19	28	146	152	14	50	78°α
5.6	2218			14930	9000	950	52	48	68	88	28	28	142	156	14		

[illegible]

82

Q FAN DEMONSTRATOR

$6.1, \dot{\omega} \approx 15 \text{ rad/sec.}$

[illegible][illegible]

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AMB TEMP.
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

84	86	91	93
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DATE 9-19-77

SHEET NO. 5

Q FAN DEMONSTRATOR

7.1 = 12 lb. sec $\frac{7}{8}$ in

6.3 = 15 lb/sec ft = SHEET NO.
6.4, 6.5, 6.6 = 20 lb/sec ft
6.7, 6.8 = 25 " "
6.9, 6.10, 6.11 = 30 " "

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
6.3	1809	:14		12420	8730	840	43	32					101	128	13	52	$\alpha=55$ $V=105$
6.4	1816	:21		14080	8180	910	52"	47	65	86	22	28	110	135	14	54	$\alpha=62$ $V=105$ $\alpha=65$ $V=105$
6.5	1819	:24		14100	8200												$\alpha=66$ $V=105$
6.6	1821	:26		14100	8170	920	52	47	64	90	21	29	115	139	12	42	$\alpha=66$ $V=105$
6.7	1831	:36		15870	10850	1020	52	55	70	94	42	27	125	160	13	42	$\alpha=77$ $V=105$
6.8	1837	:42		15870	10810	1030	52	55	70	96	41	27	132	164	15	52	$\alpha=80$ $V=105$
6.9	1846	:51		16930	12620	1180	52	68	70	99	57	26	142	180	15	52	$\alpha=85$ $V=105$
6.10	1849	:54		16910	12540	1180	52	68	70	102	57	26	146	184	15	52	$\alpha=92$ $V=105$
6.11	1852	:57		16880	12510	1180	52	68									$\alpha=95$ $V=105$
7.1	1908	1:13		10170	7660	840	43	13	46	80	3%	29	160	163	16	52	$\alpha=143$ $V=140$

[illegible]

DATE 9-19-77
SHEET NO. 6

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
7.2	1916	1:21		11750	8820	850	43	24	54	82	6	29	157/165	15	54	$\alpha = 44$ V=140
7.3	1919	1:24		11760	8800	850	43	24	53	83	6	29	156/165	16	54	$\alpha = 45$ V=140
7.4	1925	1:30		13840	8390	910	52	46	63	89	18	29	155/166	14	46	$\alpha = 50$ V=140
7.5	1932	1:37		13830	8370	910	52	46	62	93	18	29	155/167	14	47	$\alpha = 52$ V=140
7.6	1937	1:42		15670	10780	1010	52	52	69	96	36	28	155/176	15	46	$\alpha = 59$ V=140
7.7	1940	1:45		15650	10700	1010										$\alpha = 61$ V=140
7.8	1944	1:49		16750	12660	1150	52	66	70	100	52	27	157/189	15	46	$\alpha = 67$ V=140
7.9	1949	1:54		16740	12670	1160	52	66	70	102	53	23	160/195	15	45	$\alpha = 68$ V=140
	1956	2:01	4:25			SHUTDOWN										
	2245	START	4:25	10150	4660	820	52	14								

[illegible]

DATE 9-12-77
SHEET NO. 7

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.	
B.1	2253			17830	14348	1350	52	82	75	85	77	26	120	163	13	51	—	
G.I	2300				SCANI-VALVE PROBLEM --- MUST SHUT DOWN TO INVESTIGATE													
	2310	1:25	4:50			SHUT DOWN												
G.F.	2351	START	4:50	10260	47100	810	—	—	—	—	—	—	—	—	—	—	—	
9.1	2358	1:07		17770	14280	1340	52	80	72	88	76	25	127	167	14	49	8=75	
9.2	0003	1:12		17130	13000	1205	52	72	70	100	65	25	130	176	14	48	"	
9.3	0005	1:14		16030	10910	1040	52	58	70	100	46	27	134	172			"	
9.4	0010	1:19		15360	9370	990	52	50	68	97	32	28	141	167	15	49	"	
9.5	0014	1:23		12450	8080	860	43	32	55	92	11	28	147	161	15	50	"	
10.1	0021	1:30		17710	14170	1340	52	80	70	99	75	25	153	188	15	47	8=75	

[illegible]

DATE 9/19
SHEET NO. 8

ENGINEERING LOG

[illegible]

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AMB TEMP.	75
PRESSURE	
HUMIDITY	
WIND VELOCITY	
WIND DIRECTION	

DATE 9/19 E 9, 20
SHEET NO. 9

Q. FAN DEMONSTRATOR

ENGINEERING LOG

[illegible][illegible]

AMB TEMP.	22.74/7.1/78
PRESSURE	
HUMIDITY	
WIND VELOCITY	
WIND DIRECTION	

DATE 9/20/77
SHEET NO. 11

[illegible][illegible]

ORIGINAL PAGE IS
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AMB TEMP. 70/72/75/78/79
PRESSURE
HUMIDITY
WIND VELOCITY
WIND DIRECTION

Q-FAN DEMONSTRATOR

Q-FAN

DATE 9/21/77
SHEET NO. 13

ENGINEERING LOG

Run No.	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press PSI	L. Oil Temp. In	L. Oil Temp. Out	L. Oil Flow Qt/Min	L. Oil Press. PSI	Form "D" Inst.
17.8	1841	1:55		14300	8670	950	52	46	62	100							
18.1	1853	1:07		18390	14440	1490	56	88	72	97	86.5	25	163	190	14	45	$\alpha=0$ $V=1440$
	1900	G.I															
	1904	1:18	9:34														
	0018	START	9:34	10070	4590	800	52	14	60	40	4	29	104	105	14	57	65
19.1	0024			16580	12340	1110	52	62	73	72	55	28	107	141	14	57	$\alpha=0$ $V=140$
19.3	0029			15730	10840	990	52	52	70	89	40	29	112	150	14	57	"
19.5	0034			14370	8550	910	52	47	65	92	23	29	121	146	16	60	"
19.7	0039			13740	7960	890	52	45									"
19.9	0044			11140	6000	800	52	20	50	86	7	29	133	142	15	54	"

VIBRATION - 4 MILS								ENG/COWL TEMP DEGS F									
ENGINE			INLET		GB		DUCT	1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9	10
1.2	-	.2	.5	.2	.4	1.2	1.6	(18.1)									
1.2	-	.2	.1	.1	.4	.2	.2	237	157	125	106	107	101	122			
1.4	-	.2	.3	.1	.5	.2	1.2										
1.4	-	.2	.3	.2	.9	.6	6	347	260	212	246	173	147	200			
1.4	-	-	.5	.1	.5	.5		230	188	161	226	151	136	154			

[illegible]

AMB TEMP.	
PRESSURE	
HUMIDITY	
WIND VELOCITY	
WIND DIRECTION	

Q-FAN

DATE 9/22/77
SHEET NO. 15

ENGINEERING LOG

[illegible][illegible]

Amb. Temp. 90°
 Test Loc. NASA ARC

ENGINE LOG
 Q-FAN DEMONSTRATOR

Date 10/13/77
 Sheet No. 16

Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI	
1716	START	11:10	10040	4540	850	52	14	66	28	4	29	
1720	:04	11:14	HALF SPEED SHUTDOWN						- O.K.			
1818	START	11:14	10040	N ⁰ ₂ ROG	850	52	14	51	51	4	29	
1831	:13	11:27	TD	FIX	N2	SIGNAL PROBLEM (NO SIGNAL)						
										</		

L. Oil Temp. In	L. Oil Flow Out	L. Oil Press. PSI	VIBRATION - + MILS								COMMENTS
			ENGINE			INLET		GB		DUCT	
		Qt/Min	1	2	3	4	5	6	7		
12	82	9	48								SI
SHUTDOWN											
79	94	11	48	.1	0	.1	.1	.1	.1	.1	5.3

ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
1	2	3	4	5	6	7	8	9	10	1	2	3
COMP. LFF	COMP. R. RT	CONV. CAV RT	COMP. RT	FR. FRA. LT	COMP. FT, RT	CONV. CAV LT						
225	177	145	225	127	119	150				112	110	111

Amb. Temp. 81/84
Test Loc. NASA ARC

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-14-77
Sheet No. 17

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
	1725	START	11:27	10030	4480	820	52	14	74	24	3	29
	1728	:03	11:30		HALF	SPEED	CHECK		—	OK		
	1750	START	11:30	10370	4790	820	52	16	53	55	5	29
1	1804	:14	11:44	17820	14200	1360	52	82	72	90	72	26
2	1808	:17	11:48	16680	11950	1150	52	65	70	102	54	27
3	1815	:25	11:55	15400	9250	1020	52	50	67	100	32	28
4	1820	:30	12:00	13130	7050	900	52	44	57	96	16	29
5	1835	:45	12:15	12400	8030	900	43	32	55	88	10	29
6	1842	:52	12:22									

Run 23

	L. Oil Temp. In Out		L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS								COMMENTS
					ENGINE			INLET		GB		DUCT	
					1	2	3	4	5	6	7		
	79		10	51									
				HALF				SPEED					
								CHECK					
	99	101	13	57	.2	—	.2	.2	.1	.5	.3	.1	
1	93	156	13	52	.8	—	.2	.3	.3	.6	.2	.5	STILL A
2	118	169	15	53	.8	—	.2	.3	.2	.5	.6	.6	PROBLEM
3	127	161											WITH H2
4	133	152	15	55	.4	—	.2	1.2	—	1.0	.4	.3	WHEN OUR
5	144	154	15	53	.4	—	.2	.3	—	.6	.3	.2	DATA RS
6													CONNECTED

	ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
	1	2	3	4	5	6	7	8	9	10	1	2	3
1													
2													
3													
4													
5													
6													
7	228	179	142	228	128	118	150				119	116	110
8	554	446	139	518	177	155	233				216	182	222
9	500												
10													
11													
12													
13													
14	319	246	181	316	182	157	196				167	159	168
15	296	230	172	293	173	150	187				176	166	178
16													145

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Test Loc. NASA ARC

Q-FAN DEMONSTRATOR

Q-FAN

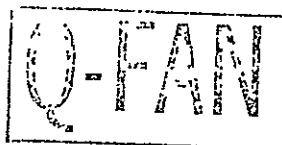
Sheet No. 18

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ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
1	2	3	4	5	6	7	8	9	10	1	2	3
										141	139	144
551	437	151	521	175	141	246						
291	221	169	211	169	115	184						146

Amb. Temp. 78
 Test Loc. _____

ENGINE LOG
 Q-FAN DEMONSTRATOR



Date 10-14-71
 Sheet No. 19

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	2138	:38	13:00	17880	14410	1370	52	82	71	96	78	25
2	2142	:42	13:04	17120	12880	1210	52	71				
3	2145	:45	13:07	15920	10710	1040	52	55	69	100	43	27
4	2149	:49	13:11	15060	8960	990	52	49	66	97	30	27
5	2152	:52	13:14	14530	10430	970	43	47	64	96	19	28
6	2155	:55	13:17	13280	8790	930	43	44				
7				15920	13540	1060	43	54				

RUN 25

	L. Oil Temp.		L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS							COMMENTS
					ENGINE		INLET		GB		DUCT	
	In	Out			1	2	3	4	5	6	7	
1	149	185	15	50	.9	-	.2	.4	.6	1.6	1.8	.8
2	151	190	15	51								
3	155	182	15.5	51	.5	-	.2	.2	.1	.8	1.0	.4
4	150	174	15.5	50								
5	161	176										
6					.7	-	.2	.2	.2	1.0	.5	.8
7												

	ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
	1	2	3	4	5	6	7	8	9	10	1	2	3
1	558	443	162	510	191	146	248				236	214	238
2													
3	454										214	188	203
4													
5	356	272									200	186	212
6	313												
7													

Date 10-11-77
Sheet No. 20

[illegible]

Amb. Temp. _____
Test Loc. _____

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-14-77
Sheet No. 21

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1				17610	14110	1320	52°	78	71	93	71	26
2				16780	12560	1170	52	66	70	99	55	27
3				15540	10250							
4	2256	1:56	14:18	14610	8760	950	52	48	66	96	24	28
5				13750	7920	920	52	46				
6	2302	2:02	14:24	13730	9530	930	43	46				
7				15340	9430	1000	52	49				
8	2307	2:07	14:29	13740	9620		43					
9	2310	2:10	14:32	14680	11050	970	43	47				

Run 21

	L. Oil Temp.		L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS								COMMENTS
	In	Out			ENGINE			INLET		GB		DUCT	
					1	2	3	4	5	6	7		
1	166	175	15	50	.9	-	.2	.4	.2	2.0	3.0	1.5	ENGINE
2	166	198											TURBINE
3	169	179	16	50									SEPARATION
4	170	183											OUT OF SEP
5													
6		177											
7	171	178											
8													
9	169	181			.6	-	.2	.4	.2	1.5	2.0	2.0	

	ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
	1	2	3	4	5	6	7	8	9	10	1	2	3
1	541	430	119	359	170	147	232				245	226	217
2													
3	418	344	193	374	181	157	220				237	216	211
4													
5													
6											210	196	216
7													
8													
9													
10													

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Amb. Temp. 84
Test Loc. _____

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-14-77
Sheet No. 22

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	2314	2:14	14:36	17780	14370	1360	52	80	71	100	74	25
2	2318	2:18	14:40	16900	12700	1180	52	68				
3	2321	2:21	14:43	16260	11540	1080	52					
4	2323	2:23	14:45	16020	11110	1060	52	57	69	100	114	27
5	2326	2:26	14:48	15670	10440	1010	52	52	59	90	39	29

Run 28

	L. Oil Temp. In Out		L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS							COMMENTS	
					ENGINE			INLET		GB			DUCT
					1	2	3	4	5	6	7		
1	167	200	16	50	1.0	-	.2	.8	.6	2.0	2.5	2.5	
2													
3	171	196											
4	173	194	16	50	.6	-	.2	.8	.4	1.8	3.0	2.0	
5	174	191											

	ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
	1	2	3	4	5	6	7	8	9	10	1	2	3
1	557	441	202	491	189	156	231				249	230	252
2													
3													
4													
5													

Amb. Temp. _____
Test Loc. _____

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-14-77
Sheet No. 23

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	2335	2:35	14:57	18220	15000	1450	52	85			82	
2	2337	2:37	14:59	16250	11290	1080	52	59			48	
3	2342	2:42	15:04	13540	9160	930	43	46			15	
1	2352	2:52	15:14	18620	14620	1540	56	90	72	105	74	
2	2356	2:56	15:18	18330	15158	1490	52	97	71	107	95	
3	0000	3:00	15:22	17890	14230	1390	52	81	70	111	76	
4	0002	3:02	15:24	17540	13600	1300	52	78	70	110	70	
5	0004	3:04	15:26	17180	12900		52					
6	0006	3:06	15:28	16520	11700	1120	52	63	70	106	52	
7	0009	3:09	15:31	16000	10800							

	L. Oil Temp. In Out			L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS								COMMENTS
						ENGINE			INLET		GB		DUCT	
						1	2	3	4	5	6	7		
1	176	210	16	50		1.1	-	.3	.2	.4	.6	.2	.2	
2	177	206	15	50										
3	174	220												
4														
5														
6	189	211	16	48		1.0	-	.6	.4	-				
7														

	ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
	1	2	3	4	5	6	7	8	9	10	1	2	3
1													
2	459	377	167	420	192	152	193						
3													
4													
5													
6													
7													
8													
9													
10													
11													
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99													
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Q-FAN

Date 12-14-77
Sheet No. 24

Amb. Temp. _____
Test Loc. _____

[illegible][illegible][illegible]

Date 10-15-77
Sheet No. 25

[illegible]

Amb. Temp. 79/83/89/92
 Test Loc. _____

ENGINE LOG
 Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77
 Sheet No. 26

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	13:42	:31	16:24	12800	9130	880	43	40	57	89	10	28
2	13:47	:36	16:29	12790	9240	880	43	40	58			
3	13:48	:37	16:30	12770	9240	880	43	40	58	86	10	28
4	13:50	:39	16:32	12780	9240	880	43					
5	13:54	:43	16:36	14500	8700	960	52	49	66	87	24	28
6	13:59	:48	16:41	14710	8960	960	52	49	67	91	25	28
7	14:07	:56	16:49	14740	9030	970	52	49	67	94	25	28
8	14:11	1:00	16:53	14760	9040	970	52					
9	14:18	1:07	17:00	15790	10880	1040	52	56	69	95	39	
0	14:20	1:09	17:02	15850	10910	1040	52					

	L. Oil Temp. In Out		L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS								COMMENTS
					ENGINE			INLET		GB		DUCT	
					1	2	3	4	5	6	7		
1	116	141	15	59	.7	-	.9	1.8	-	1.0	2.5	1.5	$\alpha = 48^\circ$
2													$\alpha = 50^\circ$
3													$\alpha = 52^\circ$
4	122	144	15	57									$\alpha = 53.5^\circ$
5	127	147	15	57	.5	-	1.0	1.4	-	3.0	2.0	3.0	$\alpha = 59^\circ$
6	130	151	16	57									$\alpha = 60^\circ$
7	134	155	16	57	.7	-	.7	1.2	-	1.5	2.5	1.0	$\alpha = 62^\circ$
8													$\alpha = 64^\circ$
9	140	165	15	52									$\alpha = 60^\circ$
10													$\alpha = 70^\circ$

	ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
	1	2	3	4	5	6	7	8	9	10	1	2	3
1	303	232	168	280	171	149	181				161	153	167
2													
3	303	233											
4			168	273	168	149	179				168	157	173
5													
6	314	219	174	301	180	166	200				182	166	184
7	311	281	197	310	184	164	201				186	179	175
8													
9													154
10											202	176	206

Amb. Temp. 93/97/100
Test Loc. _____

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77
Sheet No. 27

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	1423	1:12	17:05	15870	10870	1040	52	56	70	95	40	27
2	1425	1:14	17:07	15860	10820	1040	52	56				
3	1429	1:18	17:11	17330	13630	1270	52	76	70	97	63	25
4	1432	1:21	17:14	17350	13570	1270	52					
5	1434	1:23	17:16	17340	13550	1270	52	76	70	101	63	24
6	1438	1:27	17:20	17360	13580							
7	1439	1:28	17:21	17350	13520	1280	52					
8	1443	1:32	17:25	18330	14210	1470	56	89	71	106	86	25
9	1447	1:36	17:29	18400	14300	1480	56					
10	1449	1:38	17:31	18400	14350	1480	56					

1	L. Oil Temp.		L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS								COMMENTS	
	In	Out			ENGINE			INLET		GB		DUCT		
					1	2	3	4	5	6	7			
1														$\alpha = 72^\circ$
2	142	170	15	52										$\alpha = 74^\circ$
3	145	183	15	52	1.0	-	1.0	.5	-	.8	.6	.8		$\alpha = 60^\circ$
4														$\alpha = 75^\circ$
5	148	192	16	52										$\alpha = 77^\circ$
6	150	194												$\alpha = 79^\circ$
7	153	197												$\alpha = 81^\circ$
8	158	222	16	51	1.2	-	1.0	.8	.4	1.5	1.8	2.0		$\alpha = 60^\circ$
9														$\alpha = 75^\circ$
10														$\alpha = 81$

	ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
	1	2	3	4	5	6	7	8	9	10	1	2	3
1													
11													
12	461	364	127	400	72	152	310				157	152	2.1
13													
14													
15	538	435	142	387	184	162	225						
16													
17													
18	595	475	129	250	193	171	218				221	228	252
19													
20													

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Amb. Temp. 101/104/92/99
 Test Loc. NASA ARC

ENGINE LOG
 Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77
 Sheet No. 27

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	1451	1:40	17:33	18400	14350	1490	56°	89	70	112	85	25
1	1504	1:53	17:46	18150	14100	1420	56	87	70	109	80	25
2	1507	1:56	17:49	18160	14060	1440	56	87	70	110	80	26
	1516	2:05	17:58		SHUT DOWN							
	1603	START	17:58	10140	5600	870	43	15	45	74	4	29
1	1615	1:12	18:10	10200	8130	870	43	15	46	75	2	29
2	1618	1:15	18:13	10200	8130							
3	1621	1:18	18:16	14940	9490	990	52	50	67	80	25	28
4	1623	1:20	18:18	14990	9600	990	52	50	67	88	25	28
5	1626	1:23	18:21	15010	9600							

1	L. Oil Temp.		L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS								COMMENTS		
	In	Out			ENGINE			INLET		GB		DUCT			
					1	2	3	4	5	6	7				
1	162	9.12	17	55										$\alpha = 8.10$	
2	177	3.15	17	55	1.0	-	1.0	.7	.5	2.0	2.0	2.0		$\alpha = 7.1^\circ$	
3	177	2.17												$\alpha = 7.1^\circ$	
					SHUT DOWN										2000 Pylon Cable in Turn
1	142	154	15	50	.4	-	.2	1.0	-	2.0	4.0	6.0		$\alpha = 3.9^\circ$	
2														$\alpha = 4.1$	
3	141	160	15	50	.8	-	.2	1.6	-	2.0	3.0	4.0		$\alpha = 4.5$	
4	141	163												$\alpha = 5.0^\circ$	
5														$\alpha = 5.2^\circ$	

	ENG/COOL TEMP DEGS F										BRG. RACE TEMPS		
	1	2	3	4	5	6	7	8	9	10	1	2	3
1	588	469	129	410	195	171	250				253	232	256
2											253	231	250
	SHUT DOWN												
1	236	188	142	227	145	136	156				168	162	171
2											161	176	204
3													
4													
5													

Amb. Temp. 101/104/108
Test Loc. _____

ENGINE LOG
Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77
Sheet No. 29

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
6	1628	:25	18:23	16440	12210	1110	52	63	69	96	46	27
7	1631	:28	18:26	16500	12290	1130	52					
8	1633	:30	18:28	16480	12260	1130	52					
9	1636	:33	18:31	16500	12300							
10	1640	:37	18:35	17800	13310	1350	56	82	70	102	74	25
11	1642	:39	18:37	17800	13340							
12	1644	:41	18:39	17810	13380	1350	56	82	70	106	73	26
13	1650	:47	18:45	17620	13900	1330	52	80	70	109	66	27
14	1654	:51	18:49	15730	10060	1070	52	55	66			
15	1656	:53	18:51	10290	7380	880	43	13	41	104	4	29

				VIBRATION - + MILS.								COMMENTS	
L. Oil Temp.		L. Oil Flow	L. Oil Press.	ENGINE			INLET		GB		DUCT		
In	Out	Qt/Min.	PSI	1	2	3	4	5	6	7			
6	143	173	15	50	.8	-	.2	1.2	1.2	1.2	2.8	2.2	$\alpha = 45^\circ$
7													$\alpha = 57^\circ$
8													$\alpha = 59^\circ$
9	146	184	15	50	1.2	-	.2	2.2	2.2	3.0	3.0	3.0	$\alpha = 61^\circ$
10	151	191	16	51									$\alpha = 45^\circ$
11													$\alpha = 61^\circ$
12													$\alpha = 63^\circ$
13	162	202	16	51	1.0	-	.3	.6	-	.6	.8	1.8	$\alpha = 20^\circ$
14													
15	167	185											

ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
1	2	3	4	5	6	7	8	9	10	1	2	3
6	499	383	124	419	181	157	233			212	197	205
7												
8	500	384	124	460	180	151	237			213	183	200
9												
10	567	414	133	480	189	163	257			236	214	242
11												
12												
13												
14												
15	425	328	210	322	212	179	242					157

ENGINE LOG Q-FAN DEMONSTRATOR

Q-FAN

Date 10-15-77
Sheet No. 30

Amb. Temp. 107

Test Loc. _____

	Time of Day	Time This Run	Total Time	N1 RPM	N2 RPM	TT7 DEG F	BETA DEGS	PLA DEGS	Eng Oil Press PSI	Eng Oil Temp. Deg. F	Torque %	Fuel Press. PSI
1	1701	1:58	18:56	17700	14130	1340	52	81	70	102	69	26
2	1706	1:03	19:01	16290	11770	1110	52	61	68	108	42	27
3	1709	1:06	19:04	15980	11240		52					
4	1711	1:08	19:06	15620	10130	1060	52					
5	1714	1:11	19:09	15470	9910	1050	52					
1	1731	1:28	19:26	17700	13980	1360	52					
2	1736	1:33	19:31	15850	10490	1050	52	56	68	106	38	21
3	1739	1:36	19:34	10408	6650	880	43	16				

RUN 36 21

	L. Oil Temp. In Out		L. Oil Flow Qt/Min	L. Oil Press. PSI	VIBRATION - + MILS							COMMENTS	
					ENGINE			INLET		GB			DUCT
					1	2	3	4	5	6	7		
1	168	199	16	51	1.1	-	.2	.8	-	2.2	2.2	1.0	$\alpha = 60^\circ$
2	169	203			:								$\alpha = 60^\circ$
3	170	199											"
4													"
5					1.0	-	.2	2.0	-	3.0	6.0	4.0	"
6													$\alpha = 20$
7	163	194	16	52	.8	-	.2	.5	-	.5	.4	.2	"
8		181											"
9													
10													

	ENG/COWL TEMP DEGS F										BRG. RACE TEMPS		
	1	2	3	4	5	6	7	8	9	10	1	2	3
1	563	446	141	341	191	165	247				247	230	250
2													
3													
4													
5											218	203	249
6													
7													
8													
9													
10													
11	251	218	166	236	194	165	186						

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Date 10-15-77
Sheet No. 31

~~RUN 38~~

$$\begin{aligned} \lambda &= 200 \\ \lambda &= 200 \end{aligned}$$
159